October 28, 1920

Engineering News-Record

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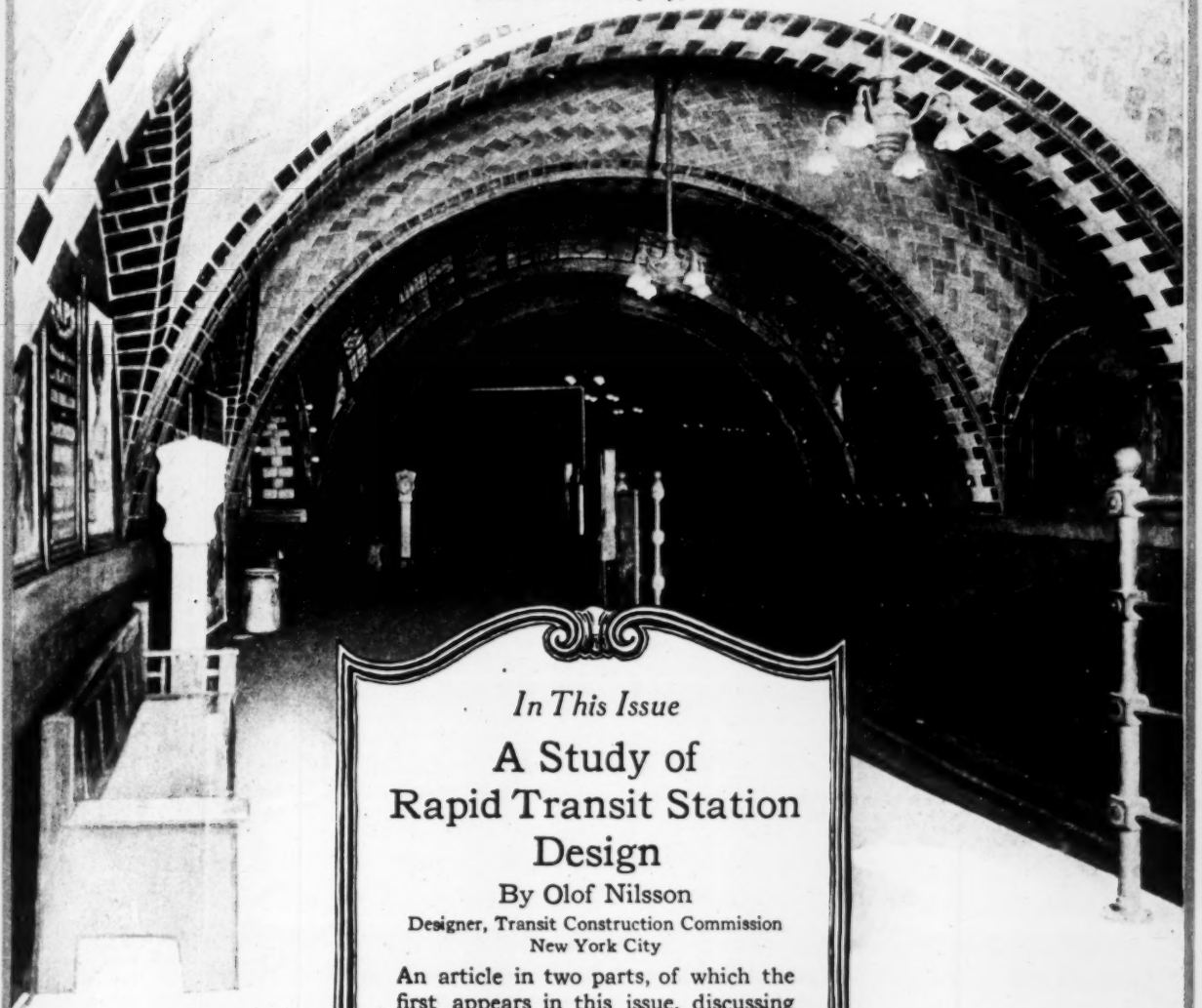


In This Issue

A Study of Rapid Transit Station Design

By Olof Nilsson

Designer, Transit Construction Commission
New York City

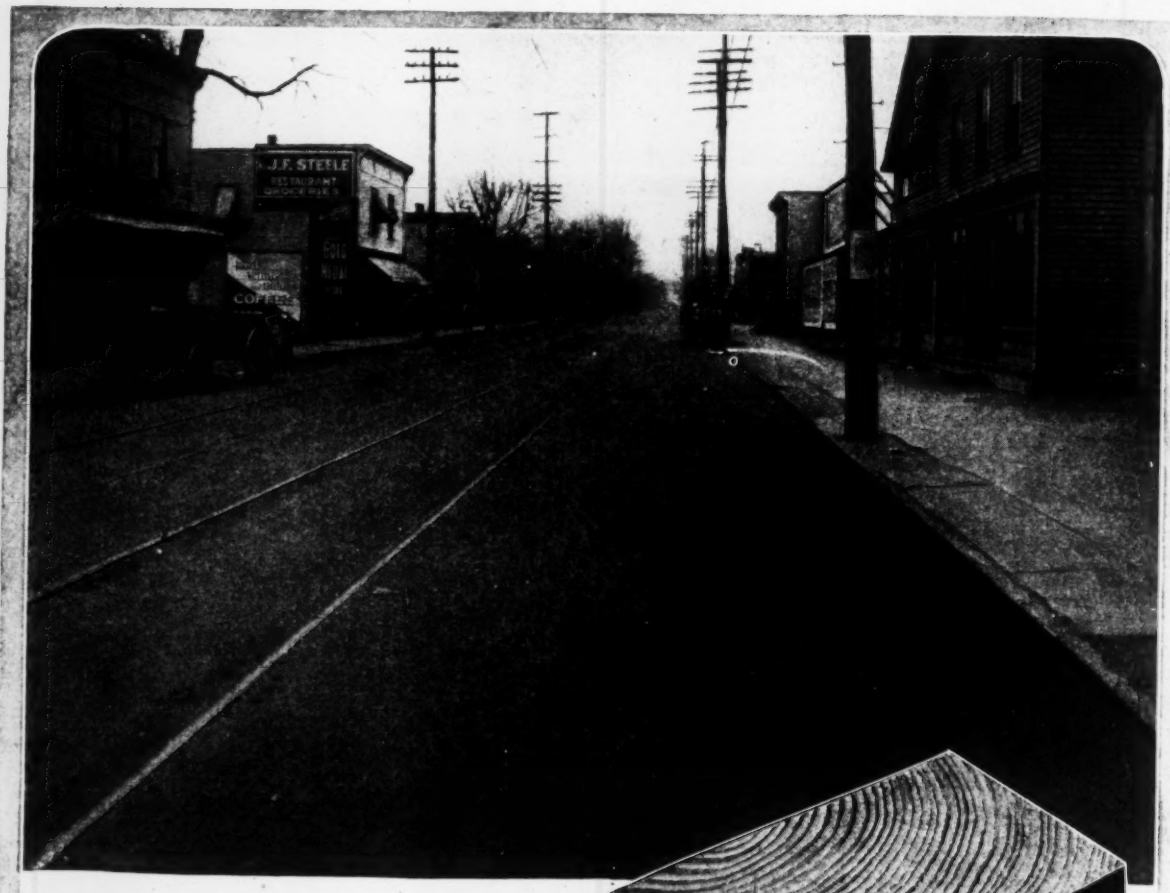
An article in two parts, of which the first appears in this issue, discussing in detail the arrangement of platforms, entrances and exits for the handling of crowds

Other Articles

Local Materials for Road Construction

Concrete Standpipe for 110-Foot Head

Charts for Solving Manning Formula



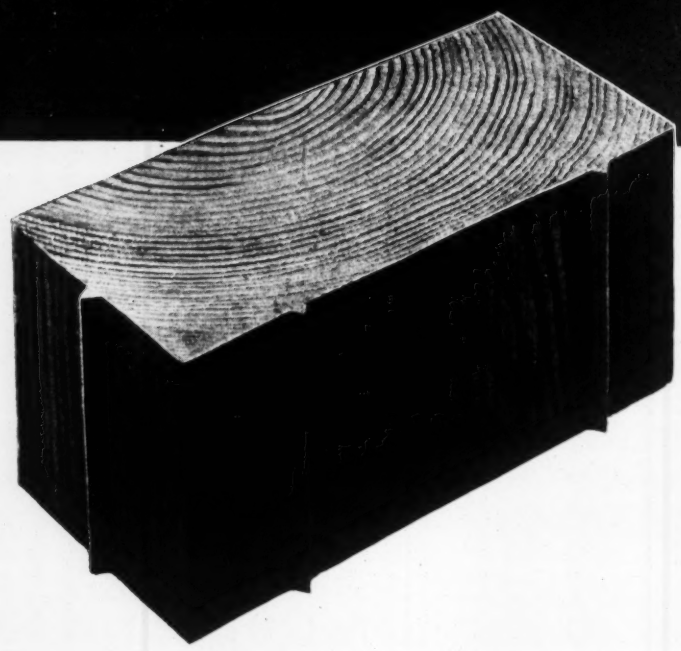
One of Toledo's Arteries

Dorr Street, Toledo, Ohio, needed repairing badly. It was almost impassable. A pavement of great endurance as well as one that was quiet and easy to truck over was necessary, as this is one of the main arteries feeding the city from the West.

Kreolite Lug Wood Blocks laid on six inches of concrete with a paint coat of Kreolite Koncrete Koating and Kreolite Wood Block Filler were finally decided upon. This pavement was laid over two years ago and is in just as good condition as when first opened.

Write for information on this superior street paving material.

The Jennison-Wright Co.
79 Kreolite Bldg., Toledo, O.



KREOLITE LUG WOOD BLOCKS

"The Paving that's Saving"

A Consolidation of Engineering News and Engineering Record — McGraw-Hill Company, Inc.—JAMES H. McGRAW, *President*

ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING
AND CONTRACTING

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Another Concrete Standpipe

HIGH concrete standpipes have not lately been so popular as their earlier construction promised. Repeated instances of leakage, notably in the case of the large Attleboro standpipe, discouraged engineers from attempting to make water-tight concrete in such large quantities to resist heads of 30 to 40 lb. per square inch, though much higher heads have been successfully cared for in the thinner but smaller units of reinforced-concrete pipe. The new Kansas City standpipe, described on another page, is therefore a notable instance of confidence in ability to produce a dense and water-tight concrete. The builders have made one innovation that will help to insure a tight structure—the adoption of the sliding form, which obviates the day's-work planes, always danger lines in concrete standpipes. But they have failed to take another precaution which some designers consider necessary—to design the steel for so low a tensile stress as to avoid cracking in the concrete when the steel is stretched under the working loads. It will be interesting to watch the Kansas City structure to see if it continues to be as tight as it now is under its 110-ft. head.

Public Health Education in Europe

IN MOST of the countries of Europe, facilities for training public health officials are very inadequate, according to remarks made by Prof. George C. Whipple in an address before the New York Section of the American Water-Works Association, last week. (See news section.) Until a dozen years or so ago the United States was equally lacking in such facilities, but the deficiency was in part made good by the instruction in sanitation given at some of the engineering colleges. Now we have a goodly number of schools devoted specifically to educating public health officers. The survey of public health education in Europe that Prof. Whipple is making for the League of Red Cross Societies promises to be of great value. It is significant that this survey is being made by an engineer. Prof. Whipple can be relied upon to point out that happy blending of education in medicine, engineering, chemistry, bacteriology, vital statistics and sociology which is essential for the capable public health officer, a course far different than it is possible for a medical school alone to offer.

The Public Works Bill

ENTHUSIASTIC support of the bill for a National Department of Public Works is needed now. If engineers are to be in evidence when this meritorious measure passes from the promotion and propaganda stage into real substance and becomes law they must maintain their moral support consistently. They are not doing it now according to the report of M. O. Leighton to Engineering Council as noted on p. 834. Legislative movements come to a head and to critical periods long before their appearance on the floor of Congress. Committees of the coming Congress will shape the bill although there is almost no chance of action until the succeeding Congress, which without doubt will pass the measure, since both major political parties have strongly indorsed the movement. Adherents of the measure, as originally defined, providing for civilian control, will find their opponents have put the whole department virtually under military control unless vigorous action is taken now to utilize the present recess period in the education of congressmen or prospective congressmen who are now at home finding out the wishes of their constituency.

Street Railways and Pavements

STRONG arguments for placing on street railway companies the cost of pavement construction and maintenance between and for 2 ft. outside their track were summarized on p. 795 last week. The forcefulness of these arguments, combined with statistics of practice throughout the United States submitted with them to a committee of the New York Senate, when joined to the opposition of the mayors of 59 cities, was sufficient to smother a bill before the committee designed to free the street railways of New York State from a considerable part of their pavement obligations. There are few, if any, municipal engineers who will not agree with the reasoning summarized in the article mentioned and heartily endorse the conclusion that since the street railways increase the cost of pavement construction and maintenance their owners, and not the abutting property owners or general taxpayer, should foot the bill. The most plausible argument to the contrary that can be advanced is that the obligation of the city to provide free streets for public travel should extend to the added burden of pavement cost and maintenance caused by the street railways. But if the extra burden on the pavements should be borne by the city, why not the cost of ties and rails? This brings to mind the fact that Liverpool, England, in connection with its municipally-owned street railways, has found it cheaper to take land and buildings for separate rights of way for street railway lines than to stand the extra cost of pavements to withstand the street railways. (See *Engineering News-Record*, Aug. 19, p. 367.) Perhaps the street railways cannot be blamed for trying to utilize the present era of high prices to get rid of the pavement charges, but as we pointed out in the editorial on "The Plight of the Street Railways," on Sept. 2, the franchises and contracts the street railways are now trying to get amended were the results of bargaining, with concessions on each side. In this bargaining the railways agreed to nickel fares and assumed certain pavement charges. If fares are to be raised, or pavement or other obligations cancelled or lightened, then the

entire contracts should be thrown open to rebargaining, or else the changes in favor of the companies should be strictly limited to a few years.

A Railroad Rate Dilemma

THROUGH the order of the Canadian Government referring the recent railroad rate increase back to the Board of Commissioners for reconsideration, the dilemma in the Canadian railroad situation is more apparent than ever. A great Government railroad system, so far a losing venture, is in competition with a great privately owned and operated system earning substantial dividends. It is stated that the rate increase, in considering the needs of the railroads as a whole, will result in unreasonably high earnings by the Canadian Pacific and such a storm of protest has been raised on this ground that the Government has recommended that the Board of Commissioners reconsider the case otherwise than on a basis of the National Railways' needs. In the United States the fear of too large earnings accruing to prosperous roads has been largely overcome by the "take-off" of one-half of all net earnings above 6 per cent of property "value." But in Canada such provision would be so obviously aimed at the great railroad competitor of the Government that it might not be sustained by the courts. There has been the proposal, open to the same objection, that the Government tax the Canadian Pacific for the "excess" of dividends. Surely the present Canadian dilemma holds a lesson for the so-called "prosperous" systems in this country that might benefit only temporarily by a supreme court decision affirming the alleged unconstitutionality of the limitation of earnings by a "take-off." Would it not be better for these companies to let well enough alone, rather than run the risk of throwing the whole question back upon Congress and the Interstate Commerce Commission?

Engineer as a Port Planner

IN HIS effort to glorify the "practical" shipping man, to which class he himself belongs, Director Sproule, of Philadelphia's Department of Wharves, in his recent address before the American Port Authorities, grouped together the politican and the engineer as joint ineffectives in port layout, and relegated the engineer to a position as day laborer to the practical man. The director's opinions are perhaps too biased by his personal position to make a reply worth while, had they not had currency as the expression of an expert. Among other things he said: "In the fact that the development of her ports and her harbors has been intrusted to impractical and technical men lies the reason this country today is secondary in importance to Great Britain and other European nations as a maritime power. The conditions arising from the European war serve to further emphasize that the extension of ports with such problems that present themselves must be intrusted to the experience of shipping and transportation experts, rather than to the judgment of those whose motives are sometimes prompted by selfishness, frequently by favoritism, and often by inexperience. Great harbors are developed only through the energy and knowledge of experienced men. The usefulness of the engineers lies largely in their carrying out scientifically the fundamental ideas of the practical man." Here, obviously, is confusion of both thought and expression. Note particularly the conjoining in the first sentence of "impractical" and "technical," the time-worn and discredited attack of the "practical" and "non-technical" man. Note, too, the misstatement in this first sentence. Quite contrary to Mr. Sproule's idea, in the ports of Europe the engineer is the directing mind, while in this country those of our ports which are most backward are those in which the sinister influence of the shipping companies is retarding proper and economic development. Those which are moving freight fastest and cheapest are headed by engineers who are expert both as planners and builders, as any true engineer must be. It is far from our intention to defend the political control of our ports, to which Mr. Sproule also is in opposition, but to drag in the engineer as a theoretical and detail-making associate of a political control is both inaccurate and unfair. The larger issue of the practicality of the engineer is not worth discussing here. Certainly, in port design and control his superiority has been sufficiently demonstrated to need no defense.

Freight Distribution at New York

AS THE GREATEST shipping center in the United States the Metropolitan District of New York, including adjacent territory in New Jersey and Connecticut, has before it a problem of freight and food distribution that is of more than local importance. Here is the largest concentration of population and of railroad and water transportation, both a point of local distribution and of transfer on a stupendous scale. Discussion of the subject last week at the first monthly meeting of the New York Section of the American Society of Civil Engineers emphasized the long-conceded opinion that present methods are antiquated, unscientific and wasteful. In the words of Shirley Eaton, of the Federal Trade Commission, "It is up to engineers to bring forth a solution." Therefore it is all the more significant that the discussion by engineering authorities brought out general agreement regarding fundamentals both in needs and new methods.

Any attempt to separate the problem of the Port of New York from that of local distribution and transfer would be difficult indeed, but there was evident agreement by the engineers on the following points: Division and distribution rather than concentration and congestion; a belt railroad system; prodigious expansion of storage; maximum movement toward point of ultimate delivery and use of small workable units; a single organization, civic or private, to direct and conduct distribution, both in and outbound, and, finally, store-door delivery. With such striking agreement there is reason to hope for action, either as a result of the coming report of the New York and New Jersey Port and Harbor Development Commission, or through concerted initiative of private shipper and carrier agencies, backed by civic authority or encouragement.

Division and distribution, rather than concentration and congestion, bear a direct relation to the belt-line project, through diversion of cars from crowded tidewater to great joint classification and receiving yards in the New Jersey meadows, and also to the expansion of storage facilities, through providing scattered points of storage and shipment-consolidation. Where present overcrowding will not admit standard-gage track connections, smaller units for transfer must be used. Here may be the opportunity for intensive operation of the motor truck in providing flexibility and maximum

movement toward point of delivery, directed by a central, co-ordinating agency. Through maximum loading and the elimination, so far as possible, of empty movement, there is reason to believe that street congestion of commercial vehicles could, by such operation, be greatly lessened rather than increased. In the city of Cincinnati fifteen motor-truck chassis, in an intensively developed service, have replaced 115 horse drays and are now reported handling 120 per cent more tonnage.

Naturally railroads are wary of store-door delivery for fear of adding to already tremendous terminal costs without additional compensation. But last week there was general agreement that no plan could ultimately succeed that would not include this provision. No attempt should be made to require the carrier to assume the additional cost—now some $2 per ton for cartage—without compensation, nor should the railroads be expected to provide greatly improved terminal facilities at huge capital costs without assurance of sufficient return on investment. Present facilities are adequate for *them* to handle present tonnage volumes, as indicated by the fact that the freight finally gets through. Civic initiative, guided by the judgment of engineers, is needed in such a development for the public good.

From the remarks of Mr. Eaton, who has made an extensive study of the subject for the Federal Trade Commission, the conclusion is easily drawn that the present situation is extremely bad. What is needed, however, is a plan based on evolution rather than revolution, above all to provide for maximum flexibility. As population and shipping have increased, the problem has become more serious, until now there is immediate necessity for action.

Steam Railroad Electrification

DISCUSSION last week at the joint meeting in New York of sections of the national societies of mechanical and electrical engineers brought out several striking aspects of the present status of steam railroad electrification. The three principal papers, extracts from which appear elsewhere in this issue, and the discussion that followed, point above all to the need for and present lack of agreement in fundamental assumptions and bases of comparison between steam and electrical operation. While the advocates of electrification made a strong case out of the probable failure of the steam locomotive to keep pace with growing demands for sustained high tractive effort at greater speeds on dense traffic zones, few engineers will be ready to relegate the steam locomotive to the scrap heap.

It is generally conceded that the large capital outlay, and the problem of disposing of steam equipment, with all its accessories, are the strongest barriers against electrification in the present state of the art. To offset these are operating economies and increases in traffic capacity from electric operation. As one authority has stated the case, "It seems to be a race between the cost of fuel and the cost of electric equipment"—which is particularly pertinent where an economical water power is available.

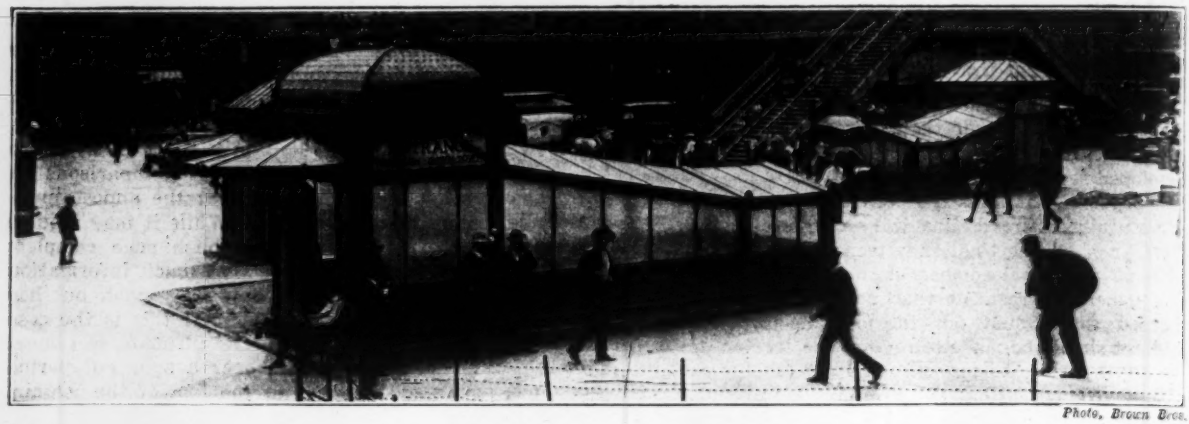
Possibilities for further development of steam-locomotive capacity and efficiency cannot be overlooked since their influence is to defer the time when it may be necessary to scrap existing steam accessories—including most of the elements of present engine terminals. It has been said that the Mallet locomotive has postponed electrification for fifteen years. Other radical departures in steam-locomotive practice, looking to considerably increased range and efficiency, without exceeding limitations of clearance and wheel loading, have been proposed, and were commented upon editorially in *Engineering News-Record* of Dec. 11-18, 1919, p. 975.

New emphasis has been laid on the lack of available comprehensive cost data in present comparisons of actual operation, taking into account the almost innumerable factors that must enter. While it may require years of further practice to establish such complete data, there is reason to believe that much information based on actual experience to date does exist, but has not been made generally available. If this is the case it is to be greatly regretted. The ultimate test must be whether the balance sheet, over a sufficient period of time, shows red or black at the foot of the column, regardless of operating luxuries, but taking into account all capital costs. The investor must be satisfied. For example, double tracking must frequently be resorted to, even though electrification would accomplish the same object as a temporary expedient. Studies that have been made for electrifying certain western mountain grades did not enter to any extent into the meeting, last week, but throughout the discussion there was recalled the principal points of those studies upon which agreement has been most difficult and upon almost any one of which the decision might hinge. Broadly, these include the questions: What is the highest practicable load factor that can be attained? What will be the cost of maintenance of all electrical equipment and of track as compared to steam operation? On what basis will existing steam equipment be disposed of and written off? Shall electric power be purchased or produced by the railroad and what will be the cost of current per kilowatt-hour? What are the practicable limits of multiple-unit electric-locomotive operation for the purpose of hauling heavier trains at higher speeds without increased crews? How many electric locomotives will be required to replace a given tonnage of steam locomotives?

In each one of these questions—and there are many others of great importance—there has been much disagreement. In a study for electrifying a mountain grade of a western line, one estimate showed a net return on net investment of only one-seventh of that indicated by another estimate for the same area, and not enough by half to justify electrification. The discrepancy was largely accounted for by wide disagreement in answers to the questions enumerated. With the present lack of available cost data from actual operation, conjecture, even though judicious, is necessarily an all too potent factor.

We heartily endorse the statement of Mr. Muhlfeld last week that further electrification studies should be made without prejudice and by joint committees composed of civil, mechanical and electrical engineers, and also representatives of the transportation and accounting departments.

The greatest credit should be accorded those who have developed heavy electric traction to its already remarkable state. Steam railroad electrification can be expected to make important gains in the next decade, but first of all in such special cases as tunnels, busy city terminals, suburban traffic, mountain grades and dense traffic zones. For some time to come the steam locomotive will hold its own for general service.



Photo, Brown Bros.

A Study of Rapid Transit Station Design—Part I

System Capacity Is Governed by Station Headway Rather Than Operating Headway—Possibilities for Great Time Saving in Platform Arrangement

By Olof A. Nilsson
Designer, Transit Construction Commission, New York City

A MODERN steam railway station is ordinarily planned to meet the comfort and convenience of the traveling public. Except as it is affected by the track layout, however, the design of the ordinary station is not influenced by the problem of operating the railroad efficiently and to its full capacity. On the other hand, the rapid transit station in a metropolis offers an entirely different problem. The design of such a station is intimately connected with the operation of the system at its full capacity, and ways and means of securing uninterrupted passenger flow are of paramount importance.

Two factors determine the passenger capacity of a railroad; the capacity of each train and the minimum headway on which it is possible to operate trains. The former, of course, depends on the capacity of each car and the number of cars in the train. The minimum operating headway is determined by one of two independent factors; the safe minimum distance between trains running at a certain speed between stations—"the running headway"; and the time required by the train to pass through a station block—"the station headway." The station headway, again, is primarily determined by the length of the train stop at the station. As ordinarily constructed, the stations are the points of slow train movement, and, in general, the station headway governs, and *the minimum operating headway is fixed by the maximum station headway on the line.*

In view of the growth of traffic on rapid transit railroads and of urban transportation in general, a growth that has been found to be much more rapid than that of the population, it is proper to assume that in time the service on at least some part of any rapid transit system will, during certain periods of the day, require the shortest possible operating headway. Every second, then, that can be cut from the length of the trainstop at the slowest station, by reducing the time required for passengers to pass between platform and train is of value, and the fundamental problem in station planning is to reduce platform congestion to a minimum and to secure a rapid and uninterrupted passenger flow between street and train. This is of particular importance with reference to main stations, at which, on account of their location, dense traffic and other conditions causing congestion and confusion may be expected. At such points an expenditure which, when considered as the cost of one station on the line only, would seem to be unreasonably high, may be entirely justified if it increases the capacity of the line.

In planning a station the starting point should be the ultimate carrying capacity of the line and the ultimate traffic yield of the district tributary to the station. From these factors and from the general scheme of operation the size and capacity of the cars and the number of cars to the train, the train length and train capacity are determined. The train length is the basis for the platform length, while the width of the platforms, the width and capacity of stairways and passages, etc., are fixed with reference to the anticipated maximum traffic flow through the station. This is seldom a simple problem. In American cities past growth is not always a safe guide in making predictions and the establishment of a rapid transit station in a district may itself give the impetus to a development, which in turn will demand additional transit facilities.

The chart on page 829 indicates how traffic has grown in New York City by showing the ticket sales at some of the important stations on the Interborough subways during the months of December for the last thirteen years. Except the Pennsylvania these stations are all on the original New York subway and its extensions to the Long Island Railroad station at Atlantic Avenue, in Brooklyn. The decrease at some of the stations in 1918 is due to the opening of the 7th and Lexington Avenue lines in July of that year, by which Manhattan was given two north and south lines instead of one. Aside from the effect of the opening of new rapid transit lines, all the stations show a continuous growth of traffic from year to year.

The heaviest station traffic in New York City today goes through the Grand Central station. The table

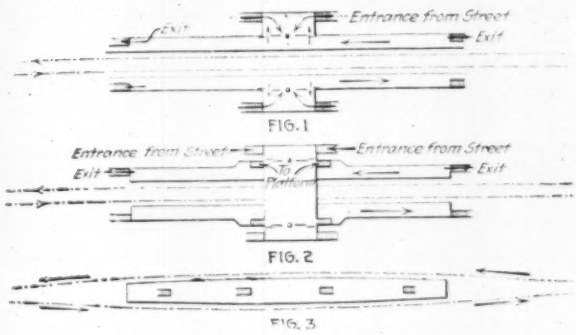


FIG. 1

FIG. 2

FIG. 3

FIG. 1. SIDE PLATFORM STATION
FIG. 2. SIDE PLATFORM STATION WITH MEZZANINE
FIG. 3. ISLAND PLATFORM STATION

shows more than 2½ million tickets sold there during the month of December, 1919, or an average on week days of between 90,000 and 95,000 per day. Twice this number will represent very closely the number of people entering and leaving the station, as it is well balanced as to traffic. In addition there is a heavy transfer movement to and from the shuttle and the Queensboro stations, as well as transfer across the platform between local and express trains. Observations on the traffic at this point lead to the conclusion that on week days about 350,000 people enter and leave the two platforms of this station, that 40 per cent of this traffic falls within the rush periods of from 2 to 2½ hours morning and evening and that in the morning the southbound and in the evening the northbound platforms have from ⅔ to ¾ of the total rush-period movement. This gives for each platform a period of from 2 to 2½ hours during which about 50,000 people enter and leave it by the stairways, in addition to the people who, without leaving the platform, use it for transferring between local and express trains running in the same direction. The total width of the stairways from each platform is 56 ft. to the mezzanine floor above and 12½ ft to the Queensboro subway below. The platforms are about 485 ft. long, have a maximum width of 24 ft. and a net area slightly over 10,000 sq.ft.

The simplest type of station on a double-track rapid transit railroad is the side-platform station. It consists (Fig. 1) of a train-platform of the required length, which is accessible from the street through an intermediate waiting-room or lobby, where the passenger buys his ticket or pays his fare. The lobby is separated from the platform or the stairway leading to it by a railing or partition, with separate openings for entrance and exit. In reality we have in this type at each stopping place of the trains two separate and distinct stations, one for traffic in each direction.

Where the elevation of the railroad with reference to the street surface permits, the two stations may be combined into one by means of a mezzanine floor either above or below the platform level (Fig. 2). This results in a saving of operating expense, since one ticket agent may, when traffic is light, serve passengers in both directions. It also enables a passenger who may have been carried past his station to return without going to the street and paying an additional fare. These advantages obtain also in the island platform station (Fig. 3). Here the tracks have been spread sufficiently to introduce between them a platform common to both.

On four-track rapid transit railroads, stations that are stopping places for trains on all four tracks must necessarily have island platforms. A usual arrangement is that shown in Fig. 4. The two outer tracks are for local trains and the inner ones for express trains. Transfers between local and express trains in the same direction are easily made by simply stepping across the platform, and the occasional traveler who wishes to turn back, can do so by the use of the mazzanine floor, which communicates with both platforms.

Classified, then on the basis of platform type, all stations are of either the side-platform type, the island-platform type, or a combination of both. With reference to location relative to the line, stations may be classified as:

(a) *Terminal stations*, which may be either the loop-end type (Hudson and Manhattan downtown terminal in New York) or the dead-end type (Brooklyn Bridge terminal New York).

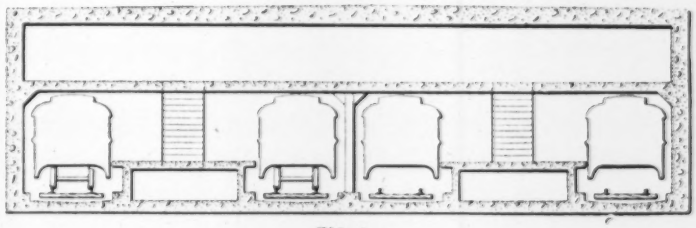


FIG. 4

FIG. 4. CROSS-SECTION OF FOUR-TRACK EXPRESS STATION

(b) *Intermediate stations.*

(c) *Stations at junction points*, where two or more lines meet, or where one main line divides into branches.

(d) *Stations at crossing points*, where two or more lines cross, either with or without track connections.

Fig. 5 indicates an arrangement at a point where a four-track line divides into two two-track branches. Fig. 6 shows how at a crossing of two lines a station may be built common to both.

The simplest conditions for station planning obtain at the intermediate station in the suburban district with largely one-way passenger movement, that is, city-bound in the morning and returning in the evening. A good arrangement is indicated diagrammatically in Fig. 7, and is self-explanatory. The passengers pass in at the entrance in the center and distribute themselves along the length of the platform during the time interval between two trains. When the train pulls in and comes to a stop and alighting passengers have stepped out, they board the train and the platform is cleared. The homeward traffic differs from the outward in this respect: whereas the outward-bound crowd gradually fills the platform during the train interval, the homeward-bound passes out on the platform during the train-stop of a few seconds and continues immediately to the street. It is, therefore, good practice to give the exits greater capacity than the entrances. This is also important for another reason. In case of an accident or a panic it is very desirable and may mean the avoidance of a great disaster to be able quickly to get the crowd to the street. From both of these view-

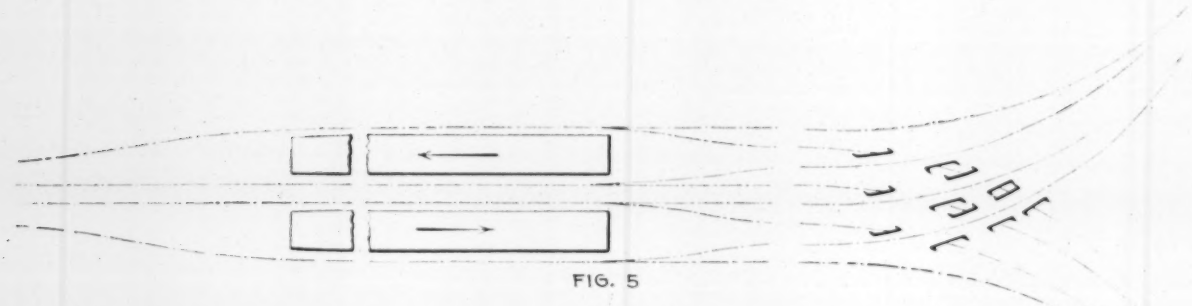


FIG. 5

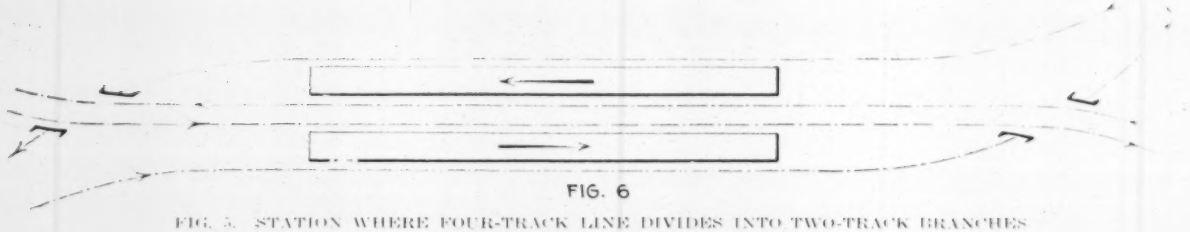


FIG. 6

FIG. 5. STATION WHERE FOUR-TRACK LINE DIVIDES INTO TWO-TRACK BRANCHES
FIG. 6. STATION AT CROSSING OF TWO LINES

points, therefore, a station of considerable length with entrances and exits at the center, may also with advantage have an additional exit at each end. If, as sometimes happens, the entrance and the ticket lobby are at one end of the platform, even an unimportant station should have at least an emergency exit at the other end.

In planning entrance and exit stairways it also makes a difference whether the station is elevated or underground. In the former case people entering the station walk up and those departing walk down; in the latter case the situation is reversed. People going down a stairway move faster than when going up, but under crowded conditions the density is greater in the upward than in the downward movement. The net result is that in crowds more people go up a stairway than down in a given period. A convenient and safe rule in figuring the capacity of a stairway is to allow for each lineal foot in width 1,000 people per hour for downward and 1,100 for upward movement. The capacities of unobstructed ramps and passages may be assumed as 2,000 per lin.ft. in width per hour. For an average walking speed of 5 ft. per second this allows 9 sq.ft. of floor space to each person.

These figures apply to stairways and passages where the movement is all in the same direction. Where people move simultaneously in opposite directions under crowded conditions the capacity is less and the width, particularly of narrow stairways and passages, should be increased accordingly. No stairway planned for simultaneous movement in both directions should be less than 5 ft. wide. Sharp turns also seriously retard the movement and should be avoided wherever possible. The maximum grade for a ramp should be 11 per cent; 8 to 10 per cent is better. For stairways the pitch adopted in the New York subways—7 in. rise and 11 in. tread—is good; when conditions permit, it is desirable to reduce the height of the riser and correspondingly increase the width of the tread according to the rule that two times the height + the width (both in inches) should equal twenty-five.

The advantage of additional exits becomes still more pronounced at a station, which by its location has more or less two-way passenger movement, that is, where during the same period passengers arrive and depart in perhaps approximately equal numbers. It is evident that the stream of passengers going toward the exit at the center, if large, will conflict with passengers coming from the entrance and walking toward the end of the platform. With exits at the platform ends this condition is greatly ameliorated; perhaps half of the outgoing passengers will use the end-exits and thus move away from, and not interfere with, incoming passengers.

There is an important difference between a station that has a one-way passenger movement and one where this movement is in both directions. In the former, nearly all the passengers travel in the same direction; during certain hours of the day they depart from the station, during other hours they arrive. At such a station, if it is properly arranged, a large traffic volume may pass through without confusion or delay. As long as the number of passengers accumulated on the platform during the interval between two trains does not exceed the available capacity of the incoming train, the people, on the opening of the doors, will quickly enter the train, and on their closing the platform will be cleared and ready for the reception of another trainload.

It is easy to see that with a simultaneous passenger-movement between train and platform in both directions, a certain number of passengers leaving and another entering the train, the conditions are less favorable to an unobstructed passenger-flow than with a one-way movement. During light traffic it does not necessarily mean confusion or a lengthened trainstop, as the passengers may enter and leave trains and pass away from the platform without obstructing each other's movements. But with dense traffic serious confusion is likely to take place, resulting in inconvenience to passengers and a lengthened trainstop with decreased capacity of the line. In the design of such a station it is therefore necessary to try to avoid interfering and conflicting passenger-movements.

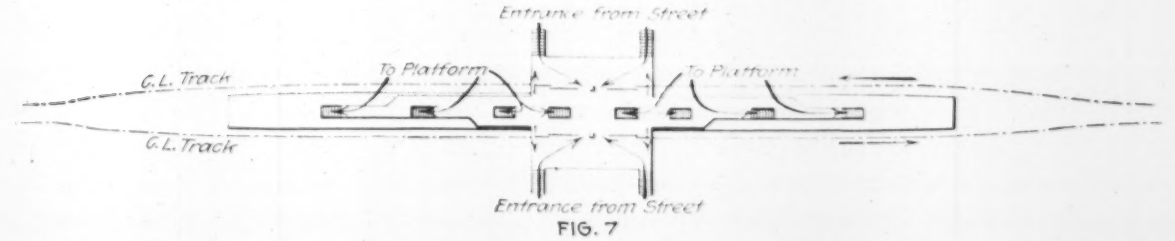


FIG. 7

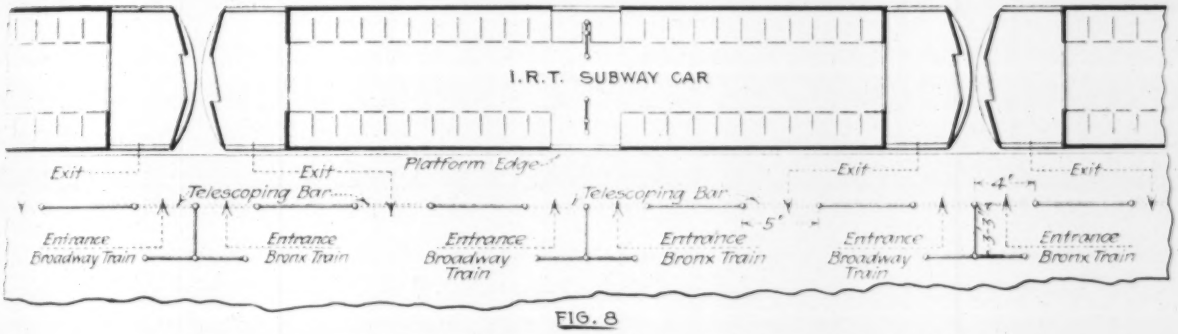


FIG. 8

FIG. 7. ISLAND PLATFORM STATION WITH MEZZANINE TO AVOID PLATFORM CONGESTION
FIG. 8. TELESCOPING BAR RAILING TO SEGREGATE PASSENGERS FOR DIFFERENT DESTINATIONS

Separate loading and unloading platforms may be used. When operating on this system the train enters the station between two platforms, the doors toward the unloading platform are first opened, and immediately after or as soon as room is made by the outgoing passengers, the passengers waiting on the loading platform are admitted. At stations with a large transfer-volume between different trains the adoption of separate loading and unloading platforms would require this transfer to be made through a mezzanine floor, subjecting transferring passengers to the inconvenience of ascending and descending a stairway.

Congestion may be reduced by ample platform width in conjunction with means for rapidly clearing the platform of alighting passengers. The station platform on a metropolitan rapid transit railroad frequently exceeds 500 ft. in length. On such a platform with only one or two exits, alighting passengers, before reaching an exit, must walk on the average one-half to one-fourth of its length. At a busy station with many passengers transferring across the platform between trains on each side and at the same time others moving in both directions longitudinally, people will naturally obstruct each other's movements and congestion and delay will result. The remedy is numerous exits in order to relieve the platform as quickly as possible of outgoing passengers. A design such as is indicated in Fig. 7 will accomplish this. Numerous stairways connect the platform with a mezzanine or passageway, which is nearly the full length of the former and located either below or above it. Outgoing passengers avoid obstructing the platform by using the nearest stairway and incoming passengers may also reach the end of the platform in the same way, and thus avoid the crowds that may have accumulated in its center.

In this connection the relation between the street layout and the design of the station may be mentioned. A station 500 ft. or more in length may have within its limits two or more important streets or other points yielding a large traffic volume. It may, therefore, have two or more entrances or entrance groups—each forming an important point of collection and distribution of passengers. If at all possible these points should be connected by a passageway or mezzanine located intermediately between the street surface and the platform. Such a mezzanine will enable passengers to traverse the distance between one end of the platform and the entrance farthest away from this end without having to work their way through perhaps the entire length of a crowded platform. If one of the streets having entrances to the station yields the greatest part of the traffic it should be near the center of the station. If there are two streets of about equal importance they should be equi-distant from the center; in short the center of gravity of the traffic should coincide with the center of the station.

The confusion incident to the use of the same platform for loading and unloading at stations with a two-way movement may be relieved by the segregation of waiting passengers within spaces enclosed by railings. Particularly where on the same track alternate trains have different destinations and therefore outgoing passengers may have to remain on the platform during two or more train intervals, until the right train arrives, this device should be useful. Fig. 8 shows such a railing which was used on the old Grand Central station of the New York subway. It was installed on the express side of the northbound platform in 1904 and was in continuous use until August, 1918. That is was an effective aid in reducing the trainstop is shown by the fact that during rush hours the average stop of northbound express trains, alternately bound for different destinations, was about 50 seconds, while that of the southbound express trains, which all had the same destination and therefore ran under more favorable conditions, was about 70 seconds. It requires the employment of platform attendants to direct the crowd, open and close the bar across the openings, and close the train doors.

While the value of the device was amply demonstrated, this particular arrangement doubtless can be improved upon. Instead of impeding the movements of alighting passengers by compelling them to make two right-angle turns before reaching the central part

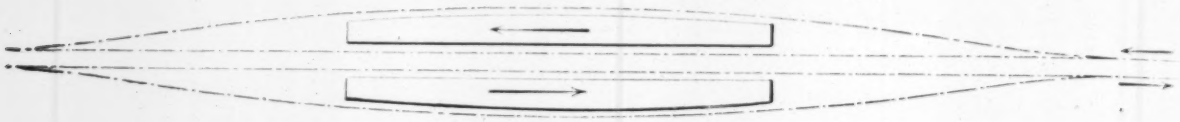


FIG. 9

FIG. 9. DIAGRAM OF RESERVOIR STATION FOR TWO-TRACK LINE

of the platform, the enclosure railing should be designed with the end in view of making the passage of both alighting and departing passengers as short and direct as possible in order to reduce to a minimum the total time required for loading and unloading. Each particular design, will, of course depend on local conditions and on the type of car used. While a satisfactory enclosure railing may often be designed to fit a platform already built, the right time to consider the advisability of this device is when the station is being designed, in order that platform width, width and location of stairways, as well as spacing and location of columns on the platforms, may all be determined upon with reference to their relation to the spaces to be enclosed. In other words, the enclosure railings, where their immediate or future adoption seems advisable, should be a part of the design of the station, not an afterthought. There might be on a rapid transit line a station or stations located at important traffic centers, with such dense passenger movement that, with even the best planned layout along the lines outlined above, they would require a considerably longer trainstop than any of the other stations and thus become limiting points for the capacity of the line. At such stations the use of additional so-called reservoir tracks should be considered. By doubling the number of tracks at the station as indicated in Fig. 9 the trains can be run alternately on each side of the platform, so that an incoming train does not need to wait for the preceding train to leave the station. By this arrangement the capacity of the station is doubled and the effect of the trainstop eliminated.

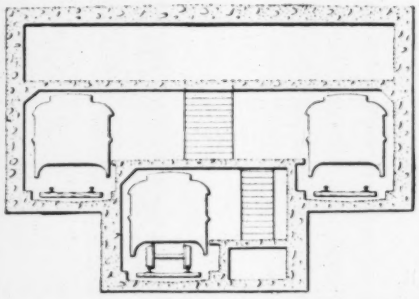


FIG. 10

FIG. 10. CROSS-SECTION OF RESERVOIR STATION WITH RESERVOIR TRACK DEPRESSED

Where the crowds go in different directions at different times of the day the two central or reservoir tracks of Fig. 11 may be combined into one. In that case, of course, connections with both main line tracks are retained. On a narrow street the additional track may be depressed under the platform as indicated in Fig. 10. A loop terminal of either a two- or four-track road is easily laid out with reservoir tracks, with or without separate loading and unloading platforms.

For a four-track one-level road it would generally be impracticable to introduce reservoir tracks on all four or even on only two tracks on one level at an intermediate station on account of the great width required. The additional tracks would therefore have to be depressed. An arrangement that would often be economical and convenient with a minimum vertical distance between platforms is indicated in Fig. 11. The upper platform necessarily has a considerably greater width than the lower one, but this is an advantage, since it must be used not only by passengers on the upper level trains bnt also by those going to and from trains on the lower level. By making the stairways between the two platforms narrow and as numerous as possible, the lower platforms could be made quite narrow and yet have the needed capacity. Even with a very narrow platform, however, the width required for a station of the type shown in Fig. 11 should certainly not be less than 120 ft. and would probably have to exceed this figure.

If the line itself is double-decked between stations the arrangement of a reservoir station becomes simply that of the two-track line, bifurcating each track on both sides of an island platform, together with means of transfer between the two levels as indicated in Fig. 12. If separate loading and unloading platforms are desired, the main-line tracks are also spread for the accommodation of an island platform between them.

On the point of safety there is one objection to the use of reservoir tracks—it introduces a facing switch on each bifurcated tracks at the reservoir station. This, however, can be avoided by the use of gauntleted tracks, which in addition would provide guard rails for the entire length of the structure thus equipped. It would, of course, add to the expense, since the tunnel would have to be somewhat wider.

The platform width is an important consideration in all of these different methods of avoiding platform congestion. Wide platforms considerably increase the cost, while, on the other hand, a platform too narrow for the needs of the station will retard train movements and therefore decrease the capacity of the line. A platform used for unloading only may be quite narrow. Even where, as would be the case at some terminal stations, a completely filled train is unloaded, a platform with an unobstructed width equal to that of the cars, say 8 to 10 ft., would be ample, since the stream of departing passengers is constantly moving and the first passengers stepping on the platform will have reached the exits before the last ones are ready to leave the train.

On a loading platform passengers waiting for a train naturally group themselves along the platform edge. Sufficient width should be allowed for these waiting passengers to permit a certain freedom of movement and to give unobstructed passage to incoming passengers. Moreover, behind these groups there should be enough width to permit people to move about between different parts of the platform and the platform stairways. Each station is an individual problem and no definite rule for platform width can be given, except the general statement that the more the conflicting passenger streams are separated into definite channels and the quicker the platform is cleared the better will be the result.

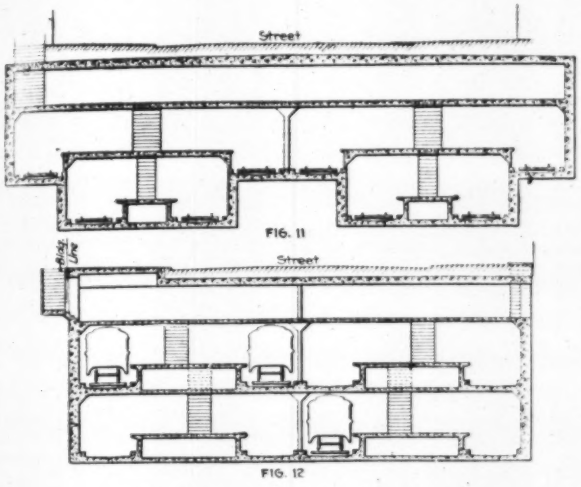


FIG. 11.

FIG. 12.

FIG. 11. CROSS-SECTION OF RESERVOIR STATION FOR FOUR-TRACK LINE WITH RESERVOIR TRACKS DEPRESSED UNDER PLATFORM

FIG. 12. CROSS-SECTION OF DOUBLE DECK RESERVOIR SYSTEM

Intelligent location and planning of the stations on a rapid transit line must be based on *the ultimate capacity of the line.* In outlying districts it may be that initial operation with say a 10- or 15-minute headway (or shorter trains with briefer time intervals) will satisfy the traffic needs even during the hours of peak-loads. But unless the building of the line has been an error, particularly if the costly subway type of construction has been adopted, the traffic will grow so that in time a 2- or 3-minute headway, or less, will be required during certain periods. Either the stations therefore must be built to suit this later condition or they must be so arranged that when the need for it occurs they can be extended without costly reconstruction.

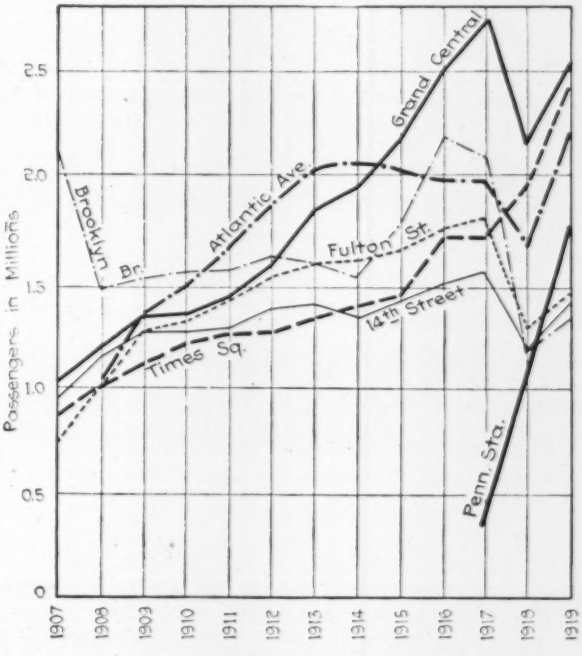
It must also be borne in mind that future extensions and increase in travel on existing lines in the outlying districts all add to the density of the passenger movements in the central district and tend to congest the stations on this portion of the line. It is of primary importance, therefore, that these stations should be capable of handling the traffic flow without impeding the train movements. At such stations it may be found that extensive changes are financially justified in order to get a station that will not limit the ultimate capacity of the line. These changes may include the widening of existing or introduction of new streets or open places as well as the acquisition of adjacent private property and the razing of costly buildings.

It may be well here to point out some factors, which, in addition to that of a well-planned station, are essential to the securing of ideal traffic conditions in general and the absence of congestion in particular. Sufficient and regular train service must be maintained. Unless the trains follow each other regularly at such intervals that all waiting passengers may board the first incoming train bound for their destination without crowding, the train will inevitably be delayed while the waiting passengers are trying to push into already overcrowded cars.

Particularly at a station so located that departing trains turn into branch lines in different directions, an irregular or improperly co-ordinated train schedule may produce almost intolerable conditions. Passengers waiting for a train to a certain point may fill up and congest the platform, while trains for other points are departing only partly filled.

Another important factor with reference both to the comfort of passengers in loading and unloading and to the time required to do this, is the type of car used. Utterly bad in this respect is the end-door car built on the lines of the steam railroad cars in use in this country. This type was adopted on the first New York subway, but it soon became necessary to remodel it, placing a side-door at the center. Compared with the first-mentioned type this side- and end-door car is a great improvement, otherwise little can be said in its favor as a car adapted to conditions that obtain on rapid transit railroads where short train stops are essential and the traffic is heavy.

The type of car in use on the New York Municipal Railway and adopted also in other cities has three side entrances and seats are arranged so that the majority of standing passengers will be grouped near the entrances. This arrangement permits comparatively rapid loading and unloading and gives greater ease of circulation inside the car.



RATE OF TICKET SALE INCREASES ON NEW YORK SUBWAYS

(Figures are for the month of December in successive years.)

Best from the point of view of speed in handling passengers and undoubtedly also from that of their comfort is the so-called Illinois Central type car placed in service on the suburban trains of the Illinois Central Railroad in 1903. Instead of an aisle in the center of the car it has narrow aisles along the sides with the seats placed transversely back to back in the center, and in addition to end doors it has a side door opposite each section of eight seats throughout the full length of the car.

(To Be Continued.)

Safety Hints for the Shipyard

Notes on Safe Practice in Hull Erection, from an Address by T. A. Walsh, of the Merchant Shipbuilding Corporation Before the National Safety Council at Milwaukee, September, 1920.

UNTIL recently it was a foregone conclusion that a real ship is never built without the sacrifice of at least one unfortunate. Since the early days of 1918, however, it has been known that avoidable accidents can be eliminated in shipbuilding as completely as in other fields of construction. By a detailed study of shipbuilding operations it becomes possible to locate the prominent causes of injury and then set about to correct them systematically.

Safe Staging Details—Planks from outside staging should number at least two at any point, and preferably three amidships, while fore and aft on the sheer there should be four, supplemented by solid staging directly aft or on the fantail. Planks should be laid so that the lap does not exceed 18 in. or is less than 12. Each tier of staging should be supplied with at least one substantial guard rail 3 ft. 6 in. above the plank; often two rails will be better. They should be bolted in place rather than nailed. A 3 x 6 timber is preferable to a 2 x 4, as men will sometimes stand or jump on them in going from one level to another.

Staging planks tend to creep from vibration set up in the construction work, and this may be overcome by the use of countersunk bolts in the ends, or by nailing cleats to the underside; both methods have proved effective. Bolting the crosslogs on which the planks rest is preferable to wedging them tight as wedges become loose and the crosslog then may creep and drop.

Ladder and Stair Safety—Ladders for access to the several levels of the staging should be tied securely at the top, should be braced at the middle, and in some cases should be cross-braced to take up sway. As standard practice they should all lean in the same general direction; generally they should lean in the direction of the descending grade.

An investigation of the use of inclines as compared with stairways for the main approach to the deck seems to have proved that the incline is most efficient and is more adaptable to the easily handling of carried loads.

Provision should be made for reaching the lower decks without going up and over, and this may be done by providing a passage through a left-off shell plate at the bow (and sometimes amidships). To reach such an opening temporary stairs have in every case proved most efficient and safest.

Hatch Staging—If the guard rail of hatch staging is left stationary when the platform is raised, so that the rail becomes too low, it may create a greater danger than no rail at all; provision should be made for keeping the rail at proper height. In engine and boiler-room hatch staging sometimes no provision is made for getting from one level of the staging to the next, and the men have to climb by means of the posts and crosslogs, a practice that creates a serious hazard. A ladder should be installed or strips should be placed on the uprights to form a ladder.

For general entrance and exit at the hatches, a temporary hatch stairway is superior to a ladder, as shown by time studies and accident statistics. The stairs will very shortly pay for themselves in reduction of accidents and saving of time of men.

Guard Deck Openings—Hatch openings, ventilators, and manholes should be guarded. Hatch openings should have substantial wooden guard rails. Heavy sections of timber will protect ventilator openings. Manholes and ventilators should have temporary covers of either wood or metal, a hinged metal cover having proved the most efficient protection. One lost-time manhole accident will frequently offset the price of a good many covers, whether of wood or of metal.

Use Goggles—Efficient goggles should be supplied to all men in pneumatic tool work to eliminate eye injuries, and steps should be taken to make sure that they are worn. Goggles should be designed to have sufficient ventilation to relieve condensation, and should be carefully fitted. Where special lenses are required in goggles, it is a wise investment on the part of the employer to see that they are furnished.

Eliminate Unnecessary Air Hose—Often ladders and stairs are cluttered with air lines, which create a serious tripping hazard. Strict supervision by foremen and safety-committee men, and the installation of pipe lines down hatches with manifolds at deck levels, will eliminate this practice; production will be increased and consumption of air hose reduced.

In connection with pneumatic work it should also be remarked that tools should have careful attention before redistribution, and the use of mushroomed sledges, flatters, and mauls, sprung wrenches or defective drift pins should not be permitted.

Safety Work Should Be Organized—Experience in several yards, both wood and steel, has shown that of the accidents in shipbuilding 95 per cent occur on the hull construction. To reduce hull accidents, in addition to providing proper construction and safe tools and methods of working, an efficient safety organization is necessary. The ship carpenter department of one yard held special departmental meetings each month, and this department was held responsible for the safety of several hundred men working on staging; as a result, the work has gone on a full year without one accident being charged to neglect of the work of this department.

As it is important that platforms and staging should be free from all warped, split and burned planks, it is apparent that an efficient staging gang must be employed. When such a gang is operating efficiently, statistics have shown that staging accidents are zero.

Causes of Asphalt Pavement Cracks and Pushing Being Investigated

IN ORDER to determine, if possible, whether cracking occurring in asphalt pavements results from improper drainage or is due to the make-up of the sheet asphalt, lengthy investigations are being undertaken by Major F. S. Besson, Corps of Engineers, U. S. A., and assistant to the engineer commissioner of Washington, D. C., upon Washington's sheet asphalt pavements. Not only is it hoped to arrive at definite conclusions regarding cracking, but investigations cover the causes of the pushing of the surface as well.

Sections have been cut from streets in various parts of the city, such specimens being taken from streets ranging in age from ten to forty years. These specimens are to be listed by degrees relative to their condition, ranging from the pavement which shows the most cracks down to the perfect pavement which neither cracks nor pushes, continuing to the end of the tabulation with the pavement which is most objectionable.

Analyses will be made of the specimens and they will be rated according to the percentages of bitumen and the gradation of the aggregate, also as to the density of the mixture and the ductility of the bitumen. Penetration and pat tests will also be made. The investigations will be extended throughout the winter and it is hoped that data of material benefit will be obtained therefrom. Asphalt considered in the test to be made will be of various kinds: Trinidad, Bermudez, California, Montezuma, Maricaibo, Aztec, etc.

The investigations made so far have led Major Besson to believe that neither do cracks in the asphalt surface relate directly to those in the concrete base, nor does the pushing of the surface depend upon the smoothness or roughness of the concrete base. It is believed that, provided there is a good rigid base, the cracking and pushing of asphalt pavements are entirely dependent upon the make-up of the sheet asphalt.

Development of Local Materials Aids Road Contractor

More Mileage With Fewer Men Result of Crusher Installation and Other Changes in Plant—Nine-Bag Batch Employed

INCREASED mileage over 1919 through the development of local materials supply, the use of a nine-bag batch mixer, and other changes in equipment and methods of operation, is the accomplishment of Quinlan & Robertson, Inc., New York City, who are building a section of reinforced concrete pavement along Route 141 of the Pennsylvania state highway system. This contract, which is one of the 1919 series, is on the Reading-Pottsville Road, lying between the towns of Hamburg and Orwigsburg, in mountainous country contiguous to the Schuylkill River.

Because of the inability of the contractor to secure and hold an adequate force of men, due partly to the remoteness of the job, construction methods followed during the 1919 season, when but 20 per cent of the contract was finished, were abandoned. A study of plant layout and construction methods requiring the least labor forces was undertaken, with the result that a central materials plant was constructed near Molino, and new equipment was purchased. During 1919 concrete was mixed in two 14-cu.ft. capacity mixers, of imported materials hauled to the road in trucks and dumped on the grade. Charging the mixers was done with wheelbarrows. The central materials plant was located at a site along the line of the Philadelphia & Reading R.R., where a deposit of boulder rock was found. The rock is of a high quality, but unfortunately runs only in seams along the mountainside. One of these seams was opened after quarry operations started during the winter. The deposit is located about 300 ft. above the railroad on a mountainside whose slope approaches 45 deg. Rock is conveyed from this quarry to the crusher by means of a double track narrow gage haulage system, in which are used two cars operated by cables wound on a double drum steam hoisting engine located above the quarry on the mountainside. It was at first thought that this material source would be adequate to supply the job with crushed stone, but recent developments show that only half the required material can be had from this quarry, a fact due to the thin deposits in which the boulders are found. The other half of the material requirements must be met by importation from commercial quarries. Fig. 1 is a view of the haulage system as seen from the top of the materials plant.

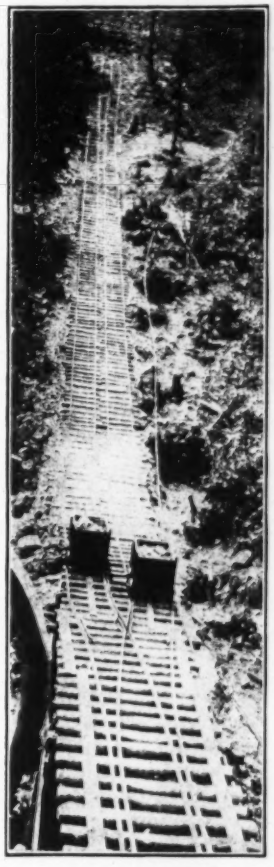


FIG. 1. SYSTEM USED IN HAULING ROCK FROM QUARRY

When the cars from the quarry reach the foot of the incline their loads of stone are dropped into the main crusher through an end door, which is released by the men feeding the crusher. From the crusher the stone is elevated to the top of the plant and put through a revolving screen having circular openings ¾ in. in diameter at the intake, and openings 2½ in. in diameter over the stone bin. "Overs" are deposited in a chute which leads to a No. 2 jaw crusher. The product of the smaller crusher is elevated and discharged through the main crusher into the elevator to the screen, thence to the proper bin.

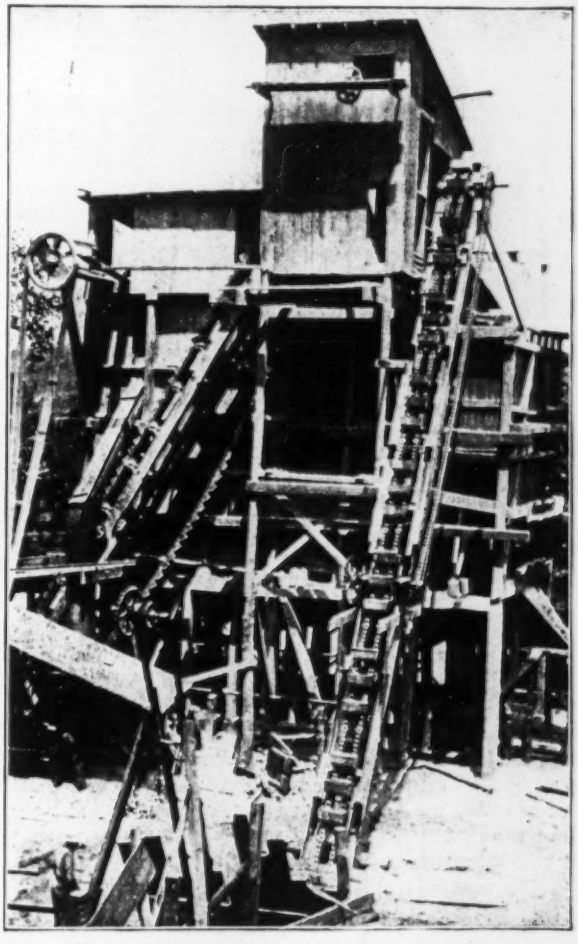


FIG. 2. CLOSE-UP OF MATERIALS PLANT

Sand is imported. It is handled by spotting the open top car over a track hopper into which the sand is unloaded, whence it is discharged into the sand bin by means of an elevator. In case the sand bin is full sand is sent from the track hopper into a small elevator which discharges the material on a storage pile on the opposite side of the track.

Fig. 2 is a close-up of the materials plant showing the sand elevator on the right and the stone elevator on the left. The return chute for oversized stone is seen over the stone elevator.

Material bins are hopper-bottom and fitted with

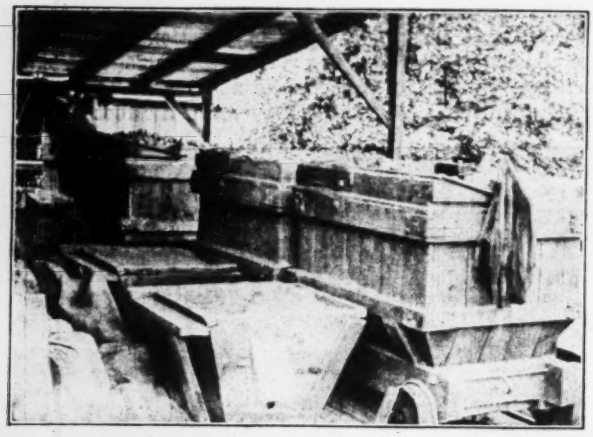


FIG. 3. CEMENT HOPPERS AND MATERIAL CARS READY TO DISCHARGE TO BATCH BOXES BELOW

slide gates. A train of four batch cars of 45 cu.ft. capacity each is run under the bins and filled with the sand and stone. The cars are divided into two compartments which, when filled level, contain the exact amount of sand and stone necessary for one batch of concrete. They operate over a track which connects the materials plant with the cement house by means of a haulage system similar to that which supplies the crushers with stone.

The cement house consists of a storage house whose floor is approximately 10 ft. above the ground line. Storage is supplied for about 4,000 bbl. in this room. A covered loading platform opens off the storage room on the opposite side from the railroad siding and to this loading platform batch cars are drawn and spotted over openings in the floor. Four cement hoppers are built into the floor opposite the openings for sand and stone. Nine bags of cement are placed in these hoppers for each batch of sand and stone. These cement hoppers and the material cars in place are shown in Fig. 3. Four 5-ton trucks drawing 5-ton trailers are used for haulage of batch boxes from materials plant to the mixer. Each truck train carries four batch boxes—two on each truck and two on each trailer. The truck and trailer drive under the loading platform and receive the charge of cement and aggregates from the platform above. Cement is discharged into a separate covered metal compartment, with which each batch box is fitted. The operation is illustrated in Fig. 4.

The mixer, whose capacity is 28 cu.ft., is charged by

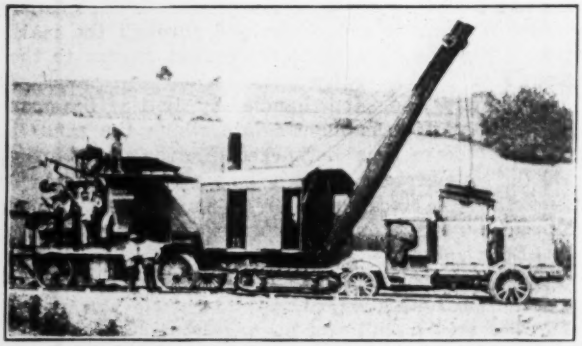


FIG. 4. STEAM SHOVEL REFITTED FOR USE AS CHARGING CRANE

a double-drum, continuous tread, steam shovel rigged as a crane. The dipper stick and crowding engine were removed from the shovel and the boom was extended about 5 ft. by channel irons fastened to either side of the outer end. Four sheaves are fitted on a shaft to the end of the boom which carry the two boom lines and the fall and dump line. The mixer and crane run near the left hand form. The trucks with trailers run to within 50 ft. of the crane, where the trailer is uncoupled and waits until the truck which continues on within reach of the crane is unloaded. The truck then backs past the waiting trailer to a point where a few omitted form lengths allow it to turn around and back up to the trailer again. While the truck is turning around, the trailer is drawn up to within easy reach of the crane by means of a cable reaved over the winding drum on the mixer. By the time the trailer is unloaded, the truck has coupled on the other end and is ready to move out.

The four trucks and trailers in use on the 2-mi. haul make the round trip in about 40 minutes. Twenty-one minutes are required to make the run from the plant to the mixer, due to the heavy grade. A truck and trailer

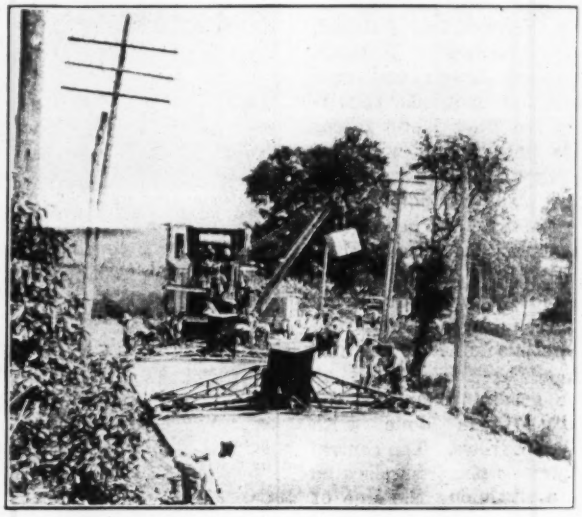


FIG. 5. FIRST FINISHER STRIKES AND TAMPS; SECOND TAMPS AND BELTS

are unloaded in seven minutes. As the net time of mixing on the job is one and one-half minutes, it requires an average of two minutes, gross, per batch. This would indicate that the handling of the batches by the crane is well proportioned for the speed of the mixer under this mixing specification.

The mixer is fitted with an overhead hopper which discharges directly into the drum through a slide gate. The rated capacity of the mixer calls for a seven-bag batch of a 1:2:3 mix. After some experimenting with an eight-bag and then a nine-bag batch, the contractor determined upon the latter as a standard size batch. Though the mixer is loaded over its rated capacity, there appears to be ample power and drum capacity to carry the extra load. The entire batch, however, cannot be conveniently carried in the discharge bucket, a small amount of concrete—approximately 10 per cent of the batch—being deposited on the grade directly from the mixer. The mixer is mounted upon wide steel tired wheels.

The finishing is done by two finishing machines, the first machine striking and tamping only, the belt being removed, and the second machine tamping and belting.

On July 27, 492 ft. of 18-ft. pavement, 6 in. thick at the edges and 8 in. thick in the center, were placed in 8 hr. elapsed time, that day being the twelfth day of operation of the plant. Prior to that time attention had been paid to details of operation and not to speed. That length is at the rate of 20 batches an hour. The contractor believes that as soon as the wrinkles in operation methods have been straightened out, an average of 30 batches an hour can be maintained, provided material supplies are adequate. The contractors' belief that increased mileage will result from perfection of organization is borne out by a recent report that in a 9-hr. day the following records were made: Aug. 26, 600 ft.; Aug. 27, 664 ft.; Aug. 28, 677 ft. With the use of a nine-bag batch 3.3 ft. of road are laid at one batch. This means that the mixer can work in one place for four batches and can use the time between truck arrivals in which to move ahead.

The following is an arrangement of all the labor used on the job:

At the mixer:
- 1 foreman fine grading and form setting
- 2 form setters
- 2 form setters' helpers
- 15 laborers, fine grading between forms
- 1 concrete foreman
- 1 hoist engineer
- 1 hoist fireman
- 1 mixer operator
- 1 mixer operator's helper
- 4 laborers handling batch boxes, trucks, trailers, etc.
- 5 concrete spreaders
- 2 finishing machine operators
- 1 finishing machine mechanic
- 2 finishers, edging, touching up
- 2 laborers, general work. Total: 41 men.

Hauling:
- 4 truck drivers
- 1 mechanic
- 2 helpers on truck repairs. Total: 7 men.

Cement House:
- 6 laborers handling cement and charging cars
- 1 engineer on haulage system. Total: 7 men.

Power House:
- 1 engineer
- 1 helper. Total: 2 men.

Materials Plant:
- 3 laborers feeding crusher
- 3 laborers unloading sand
- 1 mechanic
- 1 oiler. Total: 8 men.

Quarry:
- 1 foreman
- 8 laborers (this number varies with supply)
- 1 haulage engineer. Total: 10 men.

Total force employed: 75 men.

A. D. La Roche is manager for Quinlan & Robertson.

Activated-Sludge Plant for Reading, England

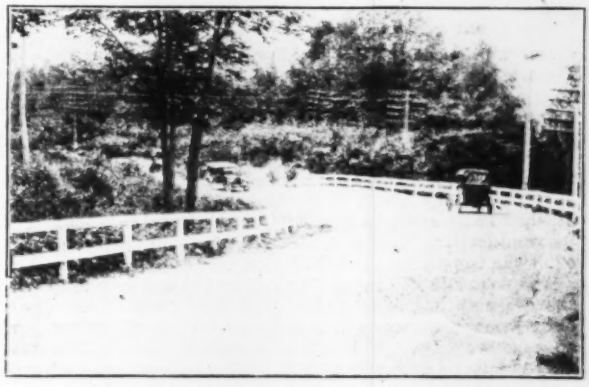
A loan of £148,000 ($719,000) for an activated-sludge plant to treat the sewage of Reading, England, has been authorized by the Ministry of Health. According to the London *Surveyor*, the activated-sludge process "is especially applicable to Reading, as a complete exclusion of rain-water from the sewerage system is effected." Plans for the new works have been made by G. Midgley Taylor, Westminster, England.

Line Controls County Road Traffic

By K. I. Sawyer,
Superintendent of Highways, Ishpeming, Mich.

PAINTED lines on the road surface, as shown by the accompanying view, have proved as useful in controlling traffic on trunk line highways in Marquette Co., Mich., as have similar control signs on city streets.

The road illustrated was originally laid out as an ore teaming track from the iron mines at Ishpeming to the boats at Marquette, and, of course, was designed only for team travel. As the road drops 900 ft. in 7 mi. through a hilly country there are numerous curves and grades. The maximum grade is 6 per cent, but some of the curves are sharper than is now considered good design for motor traffic. The traffic, which exceeds



CURVES MADE SAFE BY PAINTED CONTROL SIGNS

1,200 vehicles per ten-hour day, was beginning to be dangerous to itself, as the visibility was low on these curves, due to the shoulders of the hills and the heavily timbered country which borders the roads. To relieve this situation the writer painted white 8-in. center lines upon the black surface of the road at the more dangerous curves, with an arrow pointing down the right hand side of the road at either end. The purpose was to counteract the tendency of drivers to hug the inside of a curve regardless of the danger of hitting the traffic approaching, which might be invisible to them at the time. The effect was immediately apparent. The drivers, used to obeying control signs in the cities, immediately responded to the appeal of the white line and kept to the right hand side of the road. The immediate reduction in the number of accidents indicated that the plan was worth while.

The white paint used for this work is a whitewash prepared according to the formula used in the United States lighthouse service. The patrolman touches up the center line every Saturday morning, but unless the rains are especially severe the line will last a month.

Enormous Rainfall in Hawaii

An inch a day is the average rainfall in the upper Waipio Valley, Hawaii, which makes it one of the areas in the world where the rainfall is heaviest. On the other hand, the rainfall on some of the slopes of Hualalai, on the same island, is only 20 in. a year. The only surface streams on the island are along the northeast coast between Hilo and Kohala. Waipio River, according to the U. S. Geological Survey, has been partly developed for irrigation.

The National Department of Public Works Situation

Report of M. O. Leighton to Engineering Council States That Moral Support Is Needed Now To Finish Legislative Program—Engineer Corps Will Control Unless Civilians Act, He Says

A CALL for moral support from engineers for the bill providing for a National Department of Public Works is contained in a report which Engineering Council received at a meeting in Chicago Oct. 22 from M. O. Leighton of its National Service Department. Civilian engineers, it is claimed, will be outmaneuvered by the Corps of Engineers, U. S. Army, unless there is a decided revival of the interest in the public works department exhibited 18 months ago. Other professions and organizations, it is pointed out, are taking up the engineers' program and will follow it through. Extracts from Mr. Leighton's report follow:

Resumption of legislative effort in support of a National Department of Public Works will take place prior to the next meeting of Council. It therefore appears advisable to make a rather complete report on the progress of that movement.

Two outstanding facts may be mentioned: The first is that the engineers of the country in good faith started in 1917 something which they do not now seem inclined to finish. The second is that the scope of the movement and its ramifications extend beyond all limits written or spoken of at the time.

The writer is unable to suggest any adequate reason why the original enthusiasm of so many engineers has apparently been reduced to a passing interest. Engineers responded warmly to it in the first instance and it therefore may safely be assumed that they had an original and genuine regard for it. The writer has considered the possibility that the engineers may be discontented with the conduct of the public works campaign and the personnel engaged therein. This, however, seems doubtful, because of the fact that the campaign has been successful to a degree beyond that anticipated at the beginning by those most familiar with the situation.

No doubt the enthusiasm of many engineers has been cooled, and in some cases their active opposition has been brought about by the very skillful campaign carried on by members of the Corps of Engineers, U. S. Army. We do not complain of such activities of the Army engineers. Their opposition to a public works department was expected. Many of the civilian engineers on whom we counted for support have been won over to the cause of the Army engineers, and as magnanimous opponents we must congratulate the Corps on its achievement.

Government Reorganization

The fundamental arguments for a department of public works apply with equal force to the entire Government organization. There has grown in a short space of time a country-wide movement for Government reorganization. The National Education Association, the Women Voter's League and the Federation of Women's Clubs are supporting a proposed department of education. The American Public Health Association and other organizations in the realm of sanitation and preventative medicine are supporting a department of health. Certain welfare organizations are advocating a department of public welfare, and there is also a movement for a department of aeronautics, and, as some of you are aware, an old movement for a department of mines still exists. The National Budget Committee, having practically completed its labors in behalf of a budget system of Federal finance, is actively turning its attention to the entire field of Federal reorganization.

The National Budget Committee, the Public Works Department Association, and the National Education Association are participating in the activities of what is known as the National Committee for Government Economy, the purpose of which is to make and report upon a complete study for governmental reorganization. The report is practically completed. In all of these organizations, with possibly one exception, the creation of a department of public works is an accepted doctrine.

Early in October there was a meeting in New York City, attended by John T. Pratt, the head of the National Budget Committee; Herbert Hoover; Henry L. Stimpson, former Secretary of War; Paul Warburg; Major C. T. Chenery, and the writer, at which matters of Government reorganization were discussed, and particularly the need for and the possibility of amalgamating all reorganization efforts under a commonly accepted and supported program. It was brought out that if the many organizations conduct campaigns separately, each for its own particular project, the confusion created in Congress will probably result in no legislation. It was therefore decided to call a meeting of delegates from the several organizations advocating reform in the Government departments, for the purpose of organizing a Federal Reorganization Council, which would be the common body through which an accepted program would be carried forward.

A meeting of such delegates was held in New York on Oct. 14 at which time the nearly completed report of the National Committee on Governmental Economy was presented. That program provided for a general rearrangement of Government activities along functional lines, including the creation of a department of public works by a reorganization of the present Interior Department. The meeting for final organization will take place on or about Nov. 15. The prospective field of such a council is not limited to the mere reorganization of Federal activities. It should, if properly conducted and supported, become the authoritative unofficial body to engage in the work which will eventually lead to a distinct separation of the political features of our Government system from the conduct of departmental business.

There is also being discussed the consolidation of the Public Works Association with the National Budget Committee. This move appears to be wise from the standpoint of efficiency and economy.

The obvious result of all this is that a department of public works, if created, will not be an achievement of engineers and architects solely, but of men and women of many professions and vocations. Such credit as will come to the engineers will be merely that of starting a good thing, unless the members of the profession revive their interest and resume a leading part in the campaign. If such a revival does not take place the cream of achievement will be skimmed by the members of other professions.

To summarize as to the prospects for a department of public works: It is the writer's belief that the principle is thoroughly settled in the minds of the public and of a majority of the members of Congress. The important question remaining is the kind of a department that we shall have. This involves a discussion of the matter of engineering control of the Government operations. Shall it be civil or military?

Civil or Military Control?

It is easy enough for the thousands of engineers of the United States to assert that the engineering work of the Government shall be under civilian control, but it is quite another thing to establish that control. It is not difficult for the civilian engineers of the country to set up the claim that our military engineers are not well-rounded engineers; that they are inbred; that the greater part of their meritorious performance is done by their civilian assistants who secure no credit therefor; that the Corps of Engineers is an autocracy and therefore unsuited to the control of public operations in a democracy.

Unless one scans the record very closely he will fail to

appreciate how intimately the military organization has interwoven itself into the structure of civil government, and with what ingenuity it has placed landmarks that stand as a constant reminder of the civil achievements of the military engineers. These landmarks are placed where they will most frequently fall under the eye of the members of Congress. If a new road is built in one of the parks of the District of Columbia—just an ordinary road involving horse sense and an adherence to fundamental principles—it is likely to be named after the military head of the office under which the construction happens to fall. If dam construction is proposed, the lake behind the dam is named for some military engineer. By constant application and attention to detail these military engineers have, during past years, created in Congress the habit of providing that the Engineer Corps shall do thus and so, and whenever a civilian engineering organization is designated the first process is to overcome the aforesaid habit.

When Government reorganization takes place the provisions made for engineering control will crystallize and will not become mobile again for at least a generation. It all comes down to a question of what the civilian engineers want and what they will work for. They are strong enough numerically and powerful enough in influence to guide the decision if they choose to do so, but they must not entertain the notion that their adversary is asleep.

Broad Training for Army Men

If the testimony of some of the line officers, some of the engineer officers, and many of the reserve officers, be correct, the Corps of Engineers exhibited in the late war the not wholly commendable results of their high state of specialization. This ought not to be so. Our corps of military engineers should be given responsibilty and experience in every line of engineering laid open by Government activity. They should take their place in the engineering work of the arid lands and the swamps, the highways and the forests, the mines and the laboratory. They should be given the financial and the commercial training necessary to the proper conduct of operations, so that in war exigency they shall be entirely competent to perform all the engineering functions that present themselves. These facts, which it is believed no thoughtful person will deny, bring us to the forks in the road. Shall, by reason of this necessity for broad engineering training, the corps of military engineers be in command of all the Government's public works functions, to the perpetual subordination of the civilian engineer? Or shall they constitute, as was originally intended, a military arm of the Government and be given their training and experience by temporary assignment to positions in the civil work, by transfer therein according to plans most advantageous for the acquirement of such experience?

The civilian engineers of the country must decide, and if they are defeated in the forthcoming contest the fact will, in the opinion of the writer, be an evidence that the military engineers deserve their success, for it will show that whatever may be their engineering qualifications and however severely their ideals may depart from those which are supposed to constitute the cornerstone of democracy, these men do, nevertheless, possess an essential characteristic which the great body of civilian engineers does not, namely, that they know men and are ever vigilant in the exercise of their knowledge.

Rubber as Road Surfacing Material

To deaden the sound of traffic, according to the London *Surveyor*, there is now placed on Borough High St., at Southwark, London, an experimental stretch of road which is faced with rubber sheeting. Only half of the road is now being laid so as to afford a comparison in efficiency. The new material is being laid in flat slabs ¾-in. thick attached to steel plates, from which project broadly flanged studs which are gripped by the concrete foundation.

Export and Import Statistics Indicate Industrial Trend

By O. M. Fox
Construction News Department
Engineering News-Record

[*The course of business in the next six months is of such interest to every engineer and contractor that the following analysis of export and import figures merits a wide reading. The trend is not an encouraging one, but it should be in the minds of all who appreciate the all-pervading influence of our industrial situation.*—Editor.]

PRICES are never "too high" or "too low," for a long period because they invariably react to the conscienceless law of supply and demand. Such a long period of high and climbing prices as we have experienced in 1918, 1919 and until recently in 1920, would have been impossible had it not been for the loss of Europe to the world's producing or supply capacity for over four years and the devotion of America's production to engines of destruction and war-consumed goods for an equal period.

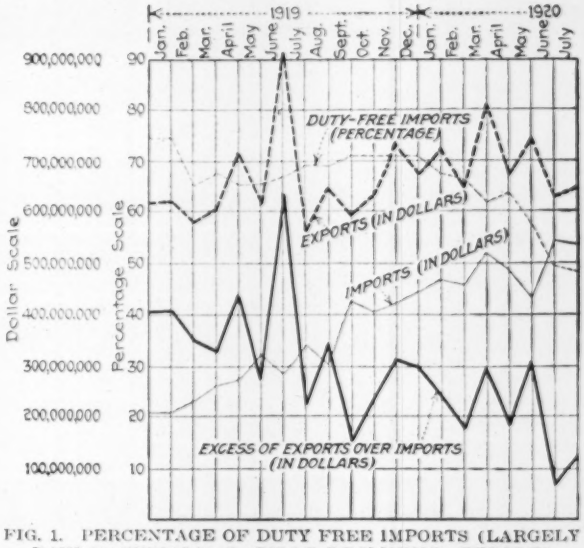


FIG. 1. PERCENTAGE OF DUTY FREE IMPORTS (LARGELY RAW MATERIALS) RAPIDLY DECLINING—EXPORTS STEADY—IMPORTS REGULARLY INCREASING

When a nation is selling more than it is buying, exporting more than it is importing, it is enjoying financal prosperity and experiencing relatively high prices at the home markets. Such has been the case in America for the past few years. An approaching change in this condition is looming every day, and presents one of the fundamental reasons for the initiation of price cutting inaugurated by the Detroit auto king on Sept. 20.

Our exports from Jan. 1, 1919, to July 31, 1920, a period of nineteen months, have totaled $12,649,000,000, an average of $666,000,000 a month. During the same period imports have amounted to $7,386,000,000, an average of $388,000,000 a month. Excess of exports over imports has totaled for the period, $5,263,000,000, an average of $277,000,000 per month.

This excess of exports, or supposed factor of safety in international trade relations, as it might be termed, is rapidly decreasing. Of these nineteen months' total, 47 per cent of the imports have been brought in and only

40 per cent of the exports have been shipped out in the last seven months—37 per cent of the time. Exports have remained practically stationary, at around $650,000,000 a month for these seven months, while imports have grown from a January-February average of $470,000,000 to a June-July average of $540,000,000. This rate of increase holds good for the entire nineteen months. The monthly figures of imports have steadily increased, with only minor downward reversions, from $213,000,000 in January, 1919, $235,000,000 in February, $267,000,000 in March, to $553,000,000 in June and $537,000,000 in July, 1920. The spread between the two, or the excess of exports over imports has therefore steadily decreased from $409,000,000 in January, 1919 to $114,000,000 in July, 1920.

This is best represented by the appended graph which shows steady convergence of the plotted lines representing exports and imports, and the corresponding steady drop of the line representing excess of exports toward the zero line. The natural bent of a student of graphs is to extend the lines in an effort to foresee the future, as moving forces tend to expend their energies along their direct lines of impulse. This must be done with caution in this case, bearing in mind that while there is a probability that the export and import lines on this chart will cross, and that before the close of this year, there is a limit beyond which they cannot pass, this limit being Europe's producing capacity and consumption requirement, coupled with our own consumption capacity.

The lines will probably tend to converge. Their approaching convergence, or crossing, will reverse the situation of the past three or four years and we will become, from a nation of profit-taking sellers, a nation of profit-paying buyers, and our commodities, following that previously mentioned immutable law, must rank lower in financial value scale and our financial prosperity must diminish.

The available statistics of the custom house show still another factor which tends to disturb our equanimity. Bear in mind that, of goods which come into this country from abroad duty-free, by far the greater portion is raw material. In order of their monetary value, the ten leading duty-free items of import are raw wool, raw vegetable fiber; raw silk; india rubber; raw chemicals; copper; crude vegetable oil; hides; tin and coffee. These are the commodities of which we must import vast quantities to keep turning the wheels of our mills and factories. The principal dutiable articles of import are sugar, tobacco, manufactured cotton, manufactured silk, manufactured wool, manufactured vegetable fibers, chemicals and similar products of foreign industry.

One of the most fruitful causes of the self satisfied days in America during the post-war period was the selfish thought that the manufacturing capacity of Europe was so crippled that for a period of years American fabricated products would not only be free from foreign competition at home but would also be free to corral the trade of the world. The figures of the government report disclose the fact that, during the nineteen-month period under discussion, while imports have been increasing nearly three-fold, the percentage of duty-free imports has decreased from 74 per cent to 49 per cent.

During this period, while our importation of raw materials has increased 68½ per cent, or $106,000,000, our finished product importation has increased 389 per cent, or $218,000,000. Foreign manufacturing interests are speedily resuming their former position of active competitors of American industry both in our own land and abroad. By just the value of these increased dutiable importations has the home market of American manufacturers been diminished, and it is interesting to note that nearly all this increase has taken place in the last seven months and is now at its highest figure in several years. The increased supply of foreign fabrications is thus seen to be co-incidental with the stagnation of American markets which has culminated in the present period of sharply shrinking values. The percentage of duty-free importations is graphically shown in the accompanying diagram.

If American business has a besetting sin, it is probably optimism, and of recent times this over-optimism seems to take the form of over-estimating markets. Our reason has been dulled by the fact that all industry is turning out and selling more production, in dollars and cents, than ever before and we have lost sight of the fact that owing to high prices the swelled financial figures represent a lessened actual material production. If less units are being sold, less manufacturing capacity is required, regardless of the total monetary value of the units themselves. A clothing factory turning out 10,000 suits at a current valuation of $500,000 is using only half the material, less labor, less power and less equipment that one turning out 20,000 similar suits currently valued at $400,000, although the first plant's money production is 25 per cent in excess of the second.

Business must therefore translate the meaning of these three shadows: (1) Imports rapidly increasing to a point where the United States no longer occupies a favorable trade position; (2) entry of foreign fabrications into active competition in domestic markets and similar competition to be met abroad; (3) consumption of goods much smaller in actual quantity, though larger in current monetary value, than has been realized. As the nation as a whole, and as the individual business units thereof, properly penetrate these shadows with the light of clear business sense, and as our economic and industrial sails are trimmed to cope with the gusts and eddies that the shadows portend, just so shall the nation and the individual business units thereof prosper in the coming year and decade.

Snow Removal From Highways

Efforts are being made to secure an announcement of policy from the Bureau of Public Roads in regard to snow removal. It is evident from these requests that the desire is that general endorsement be given snow removal on the ground that the highways represent too great an investment to be allowed to become impassable for even a short time. Thomas H. MacDonald, Chief of the Bureau of Public Roads, has taken the position that the matter of snow removal is entirely a local question. In some instances, he said, it is obvious that snow removal should be vigorously carried on, but over the great portion of the highway mileage of the country, in the snow region, he believes careful figuring must be done in order to ascertain if the expense of snow removal is justified. Where the snowfall is excessive, as in Maine, for instance, he is of the opinion that it would not be economical to attempt to keep many of the roads free from snow.

Charts for Solution of Manning's Hydraulic Formula

By Elmo G. Harris
Department of Civil Engineering, Missouri School of Mines, Rolla, Mo.

Text and charts copyrighted by Elmo G. Harris

UP TO a recent date hydraulic engineers have accepted the formula $v = c\sqrt{rs}$ and Kutter's formula for c as the best available guides for computations relating to the flow of water in any kind of uniform channel. However, writers have very generally expressed the belief, and hope, that eventually a formula, equally reliable but less tedious in solution, would be found.

It is the writer's opinion that such a formula is now offered in what is known as Manning's formula which is

$$v = \frac{1.486}{n} r^{\frac{2}{3}} s^{\frac{1}{2}}$$

Any unprejudiced reader after familiarizing himself with the able and excellent discussions of this formula by King ("Handbook of Hydraulics") must concede that computations with Manning's formula will check with those computed by the Chezy and Kutter formulas to a degree well within the errors due to uncertainty in the value of n as used in either formula.

If there remains a doubt in the mind of anyone as to whether it is safe to use Manning's formula instead of the older ones he should be reminded that they are all empirical, that they all depend for their accuracy on a coefficient that must be determined by experiment, and if that coefficient is correctly determined the formula will be correct. Any formula can be made correct by applying a proper coefficient. It is to our advantage to adopt the formula that is least laborious in the solution and then give chief attention to the determination of a proper coefficient. Manning's formula is well adapted to this purpose and it has the very great advantage that it is adapted to the values of n as already determined from a vast number of experiments. However, the reader should not fail to appreciate the fact that if Manning's formula should come into general use (which it probably will) we are perfectly justified in adopting values for n other than those fitting Kutter's formula, if in so doing we make Manning's formula better fit the facts.

The writer's contribution to the further adaptation of Manning's formula to the needs of practice follows:

In Manning's formula (see above) for v substitute

$$q/a, \text{ then } q/a = \frac{1.486}{n} r^{\frac{2}{3}} s^{\frac{1}{2}}$$

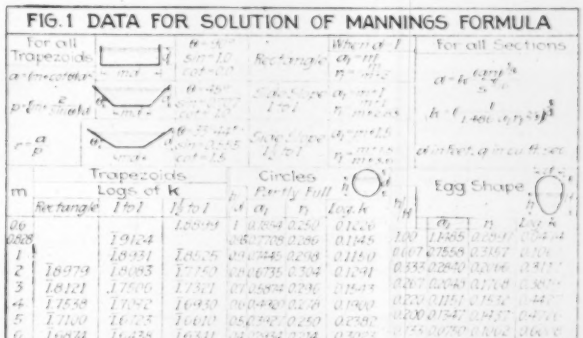
in which q = water flowing per second in cubic feet, a = area of water section. r = the hydraulic radius and s = the slope, or drop divided by distance.

It is well known (from plane geometry) that in similar figures the areas vary as the *square* of the similar linear dimensions; and the hydraulic radius of any similar set of water sections varies *directly* as the similar linear dimensions. If, then, we assign the symbol d (see cuts accompanying tables) to any one of the dimensions of a series of water sections, similar in shape but variable in dimensions, and then assign the symbol a_1 to the area of the shape when d = unity, the area of any one of the other similar sections with dimension d (other than unity) will be $a = a_1 d^2$. Similarly, if we assign the symbol r_1 to the hydraulic radius when d is unity, for any other size of the similar sections the hydraulic radius will be $r_1 d$. Hence we can modify the last equation thus

$$\frac{q}{a_1 d^2} = \frac{1.486}{n} (r_1 d)^{\frac{2}{3}} s^{\frac{1}{2}}$$

The most frequently occurring problem in hydraulic engineering is to find a dimension (as a depth or a diameter) of some specified shape of water section to carry a given quantity (q) with a given slope (s).

FIG. 1 DATA FOR SOLUTION OF MANNINGS FORMULA



Then for convenience we adapt the above equation to the solution for d, thus

$$d = \left(\frac{1}{1.486\, a_1 r_1^{\frac{2}{3}}}\right)^{\frac{3}{8}} \frac{(qn)^{\frac{3}{8}}}{s^{\frac{3}{16}}}$$

or

$$d = k \frac{(qn)^{\frac{3}{8}}}{s^{\frac{3}{16}}} \quad \text{.....I}$$

Where

$$k = \left(\frac{1}{1.486 a_1 r_1^{\frac{2}{3}}}\right)^{\frac{3}{8}} \quad \text{.....II}$$

In these formulas the symbols are as follows:

d is a dimension, in feet, of the water section, or of the conduit, chosen for convenience.

q is the quantity of water flowing in cubic feet per second.

s is the slope, or drop in free water surfaces divided by distance.

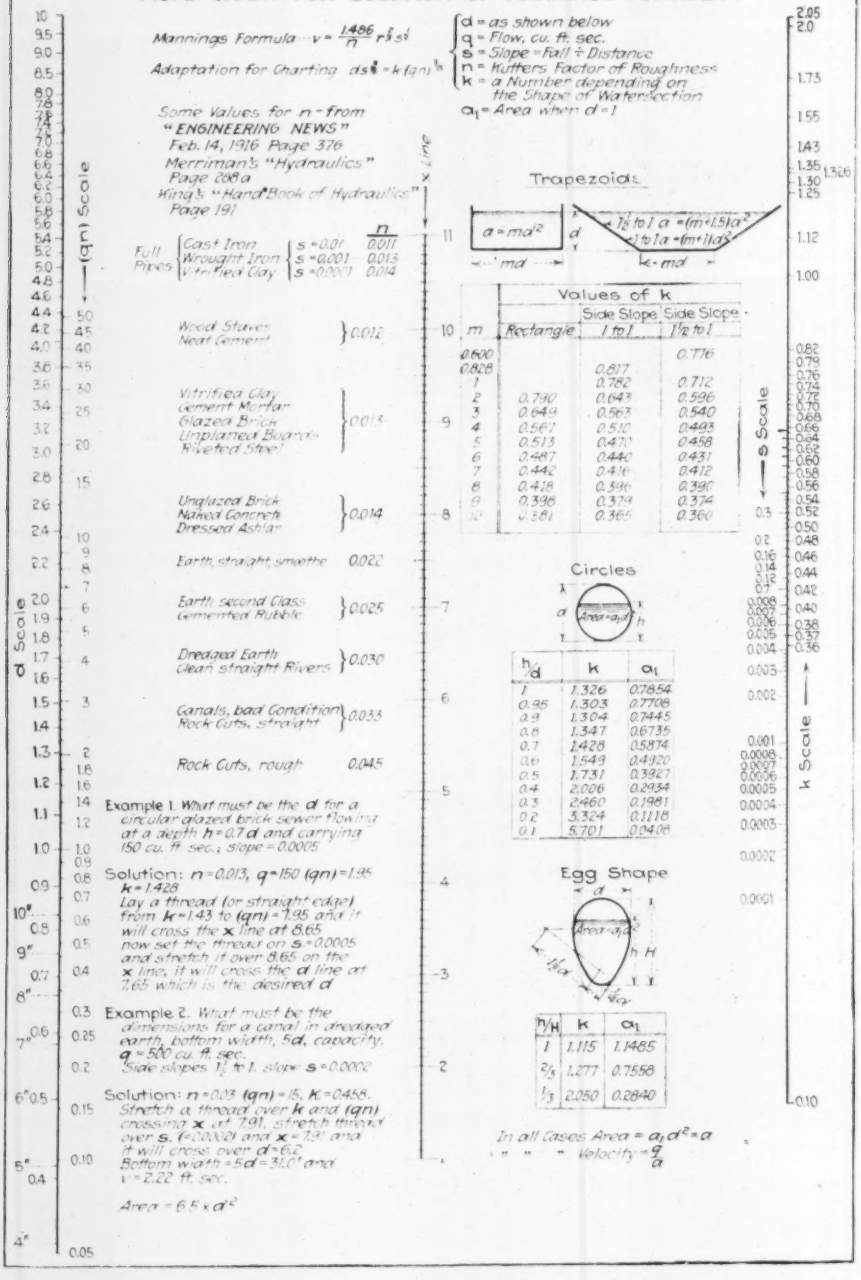
n is the roughness factor, and is the same as would be used in Kutter's formula (with exceptions as noted).

k is the shape factor in which: a_1 is the area of water section when d = one, and r_1 is the hydraulic radius of the water section when d = one

In Fig. 1 is brought together most of the special data for computations with formula I. Since the computations must be made by use of logarithms, the logarithms of k are given in the tables, thus saving the time and chance of errors in taking them out of other tables.

The data a_1 and r_1 for computing k for egg-shaped sewers is found in Folwell's "Sewerage," p. 54, and doubtless in other text-books. In the table for trape-

FIG. 2 CHART FOR SOLUTION OF MANNINGS FORMULA


Mannings Formula $v = \frac{1.486}{n} r^{\frac{2}{3}} s^{\frac{1}{2}}$
Adaptation for Charting $ds^{\frac{1}{2}} = k(qn)^{\frac{3}{8}}$
d = as shown below
q = Flow, cu. ft. sec.
s = Slope = Fall ÷ Distance
n = Kutters Factor of Roughness
k = a Number depending on the Shape of Watersection
a_1 = Area when d = 1
Some Values for n - from "ENGINEERING NEWS" Feb. 14, 1916 Page 376
Merrimans "Hydraulics" Page 288a
Kings "Hand Book of Hydraulics" Page 191
Full Pipes
Cast Iron s = 0.01 n = 0.011
Wrought Iron s = 0.001 0.013
Vitrified Clay s = 0.0001 0.014
Wood Staves Neat Cement 0.012
Vitrified Clay Cement Mortar Glazed Brick Unplanted Boards Riveted Steel 0.013
Unglazed Brick Naked Concrete Dressed Ashlar 0.014
Earth, straight, smooth 0.022
Earth, second Class Cemented Rubble 0.025
Dredged Earth Clean straight Rivers 0.030
Canals, bad Condition Rock Cuts, straight 0.033
Rock Cuts, rough 0.045
Example 1. What must be the d for a circular glazed brick sewer flowing at a depth h = 0.7 d and carrying 150 cu. ft. sec.; slope = 0.0005
Solution: n = 0.013, q = 150 (qn) = 1.95 k = 1.428
Lay a thread (or straight edge) from k = 1.43 to (qn) = 1.95 and it will cross the x line at 8.65, now set the thread on s = 0.0005 and stretch it over 8.65 on the x line, it will cross the d line at 2.65 which is the desired d
Example 2. What must be the dimensions for a canal in dredged earth, bottom width, 5d, capacity, q = 500 cu. ft. sec. Side slopes 1½ to 1. slope s = 0.0002
Solution: n = 0.03 (qn) = 15, k = 0.458. Stretch a thread over k and (qn) crossing x at 7.91, stretch thread over s, s = 0.0021 and x = 7.91 and it will cross even d = 6.2
Bottom width = 5d = 31.0' and v = 2.22 ft. sec.
Area = 6.5 × d²
Trapezoids
a = md²
1½ to 1 a = (m+1.5)a²
2 to 1 a = (m+1)a²
Values of k
m | Rectangle | Side Slope 1 to 1 | Side Slope 1½ to 1
0.600 | | | 0.776
0.828 | | 0.817 |
1 | | 0.782 | 0.712
2 | 0.790 | 0.643 | 0.596
3 | 0.649 | 0.563 | 0.540
4 | 0.567 | 0.510 | 0.493
5 | 0.513 | 0.470 | 0.458
6 | 0.487 | 0.440 | 0.431
7 | 0.442 | 0.416 | 0.412
8 | 0.418 | 0.396 | 0.390
9 | 0.398 | 0.374 | 0.374
10 | 0.381 | 0.365 | 0.360
Circles
h/d | k | a1
1 | 1.326 | 0.7854
0.95 | 1.303 | 0.7706
0.9 | 1.304 | 0.7445
0.8 | 1.347 | 0.6735
0.7 | 1.428 | 0.5874
0.6 | 1.549 | 0.4920
0.5 | 1.731 | 0.3927
0.4 | 2.006 | 0.2954
0.3 | 2.460 | 0.1981
0.2 | 3.324 | 0.1118
0.1 | 5.701 | 0.0408
Egg Shape
h/H | k | a1
1 | 1.115 | 1.1485
⅔ | 1.277 | 0.7558
⅓ | 2.050 | 0.2840
In all Cases Area = $a_1 d^2 = a$
" " " Velocity = $\frac{q}{a}$
(qn) Scale
d Scale
s Scale
k Scale
x Line

zoids the log k at top of column is that for the most economic section.

Formula I can be readily solved (by means of logarithms) for any one of the variables d, q, s, n or k, but since n will be known in all cases (except research work seeking values for n) it will save time and confusion to combine (qn) as one quantity. Then if the problem be to find q, we will first compute (qn) and divide by n.

Example 1: Determine the dimensions of, and velocity in, a canal in dredged earth with side slopes 1½ to 1 and slope 0.0005; capacity to be 750 cu.ft.sec., the cross section to be the most economic.

Solution: For dredged earth n 0.03 (see Chart II). Then $(qn) = 22.5$ and in column 1½ to 1 under trapezoids, we find for most economic section (at head of column) log. $k = \bar{1}.8899$.

With these data inserted equation 1 may be written

$$\log d = \bar{1}.8899 + \tfrac{3}{8} \log 22.5 - \tfrac{2}{3} \log .0005$$

Confusion, if any, will develop in working out the last term. The process follows:

$\log .0005 = \bar{4}.6990$ or $-4 + .6990$ and $3(-4 + .6990) = -10 + .0970$

To avoid confusion the first number (or characteristic) must be exactly divisible (in whole numbers) by 16. To get this condition add -6 to the first number and add $+6$ to the second, thus, $-16 + 6.0970$. Now divide by 16 and get $-1 + .3811$.

Then $\frac{2}{3} \log .0005 = \bar{1}.3811$

The complete computation can now be carried out as follows:

$\log k$	$= \bar{1}.8899$
$\frac{3}{8} \log 22.5$	$= 0.5071$
	0.3970
$\frac{2}{3} \log .0005$	$= \bar{1}.3811$
$\log d$	$= 1.0159$
whence d	$= 10.4$

Bottom width $md = 0.6 \times 10.4 = 6.24$, and top width $= 37.4$

Area $= a_1 d^2 = 2.1 \times (10.4)^2 = 226$, and $v = \frac{750}{226} = 3.32$

This velocity would be too great for earth. If the s cannot be reduced the most economic section must be abandoned and a flatter section adopted that will give greater friction and so reduce the velocity. Try a section in which $m = 8$.

The only change in data will be in log k, which now becomes log $k = 1.5905$. Repeating the computations we get

$d = 5.2$; bottom width $= 41.6$; top width $= 57.2$

$a_1 = 9.5$, $a = 9.5 \times (5.2)^2 = 257$ and $v = 2.92$

Example 2: Given, a vitrified brick sewer with 5 ft. diameter ($d = 5.0$), and $s = .002$; what quantity is passing when the sewer is flowing with depth $= 0.4d$?

Solution: From equation I $(qn) = \left(\frac{d\, s^{\frac{1}{2}}}{k}\right)^{\frac{8}{3}}$

$\log 5$	$= 0.6990$
$\frac{3}{8} \log .002$	$= \bar{1}.4940$
	$\bar{1}.1930$
$\log k$	$= 0.3023$
	$\bar{1}.8907$

$$\log (qn) = \tfrac{5}{3}(-1 + .8907) = \tfrac{1}{3}(-8 + 7.1256) = \tfrac{1}{3}(-9 + 8.1256)$$

$$= -3 + 2.7085 = 1.7085. \text{ Therefore } qn = .511$$

For unglazed brick $n = .014$, therefore $q = .511 \div .014 = 36.5$

If the problem be: To find the depth h, at which water will flow in a sewer when given d, q, s, and n, we would workout log k and go into the table to find the ratio $h \div d$, which ratio multiplied by d gives h.

A further reduction of the labor of computations in hydraulics is offered in Fig. 2, which is designed to solve Equation I.

The casual reader will not appreciate what is offered in the chart, but one who has struggled with the Chezy and Kutter formulas can appreciate it.

To those who may be interested in how this chart was designed the key lies in writing equation 1 thus:

$$d\, s^{\frac{1}{2}} = x = k\, (qn)^{\frac{1}{2}}$$

Here are two equations, each with three variables, (qn) being considered as one quantity and x being the same in both equations. Two charts were designed, one for each equation with the condition imposed that the horizontal spacing should be the same in each. These charts are placed one over the other. Note that we are not concerned with the numerical value of x, we need only to know the *point* on the x line that would represent x in the equation. Examples of the use of the chart are given thereon.

Finally it should be understood that Manning's formula was not designed primarily to apply to cast- and wrought-iron pipes flowing full, and for such it does not check so well with the Chezy formula. In order to get a more satisfactory check the n has been modified (varying slightly with s) as shown at top of the list of values of n on the chart. These modified values of n should also be used in computations from Fig. 1 and it would seem rational to use them for vitrified sewer pipes.

It is the writer's opinion that the chart will give results with a degree of accuracy consistent with that possible in determining n.

Since this article was prepared, a valuable contribution to information on flow of water through pipes of clay and of concrete has been supplied by the United States Department of Agriculture, Bulletin 854. The matter was prepared by D. L. Yarnell and Sherman M. Woodward, from experiments of State University of Iowa. The experiments included diameters from 4 to 12 in. The final formula recommended by the authors for such tile flowing full is $V = 138 r^{\frac{2}{3}} S^{\frac{1}{2}}$. This would give 0.0108 for the n in Manning's formula. This seems independent of S, hence, we may take $n = 0.011$ for all cases of clay and concrete tile running full. The authors do not mention Manning's formula. Evidently they derived the exponents of r and s independently, a fact that should add confidence in the Manning formula.

Government Railroad Guarantee

During the six-month guarantee period, $567,000,000 was paid to the railroads. The guarantee period ended Aug. 31, and the Treasury of the United States will be relieved of that expenditure.

Tarred Macadam Scores High in British Road Tests

AN ORDINARY tar-macadam road, constructed of a blue basaltic stone impregnated with tar and its surface sealed with distilled tar, was considered the best of a number of types including waterbound macadam, surface-treated macadam, and tar and bituminous macadam, by certain British road engineers upon observing their condition recently after subjection to five years of main-line travel. The tarred macadam was one of nine experimental lengths of roadway laid in 1915 on the Great North Road at Dunblane, West Perthshire, Scotland. Each section was about 100 yd. in length and all nine were laid at a total cost of £663. The sections are on an approximate 2½ per cent grade, in a climate where the annual rainfall is about 40 in., where temperature variations are not excessive, and where the duration of frost is normal.

The forms of construction under test were: Section 1, ordinary waterbound macadam; Section 2, waterbound macadam surface treated with distilled tar; Section 3, macadam 3 in. thick grouted with a mixture of pitch and sand; Section 4, macadam 3 in. thick grouted with pitch and oil; Section 5, macadam 3 in. thick grouted with a mixture of refined Trinidad bitumen and tar; Section 6, ordinary tar macadam composed of a tarred material surface sealed with distilled tar; Section 7, macadam impregnated with two parts of tar and one part of refined Trinidad bitumen; Section 8, a tarred material, surface sealed with Mexican bituminous mixture; and an extra section of macadam grouted with 80 per cent mexphalte and 20 per cent fluxphalte. The stone csed in all sections was blue whinstone, and according to the Road Board's provisional classification of road stone was classified as "very poor." This classification is based on physical tests only, at the National Physical Laboratory, and takes no account of the cementing properties of the stone.

Tar Macadam Section Best

Engineers making the investigation upon the test lengths agreed that Section 6 was the best and stood alone. Observations show that the average convexity of the surface on this secion had slightly increased. The surface was found waterproof, dustless, non-slippery, and durable, and not affected by atmospherical changes. It was agreed that such construction was suitable for main-road traffic under all conditions and its construction could be expeditiously carried out.

Less successful results, though not at all unsatisfactory, were secured in constructing all the other experimental sections save the first and second. These two methods of construction were condemned as entirely inadequate to main-road traffic. The slightly unsatisfactory results on other sections were due to the apparent lack of affinity between the tar surface dressing and the bitumen with which the rock was impregnated. The conclusion drawn from this observation was that where bitumens are used for the main body of the roadway it necessarily follows that the surface coat should be of bitumen as distinguished from tar. In commenting upon ths particular point W. L. Gibson, county road surveyor and engineer, Western Division, Perthshire, asserted, according to *The Surveyor*, that, as the temperature at which the bitumen is used is 400 deg. F. while the temperature of the tar rarely

exceeds 250 deg. F. one cannot expect the two materials which have no affinity to amalgamate properly.

The principal feature of the test was the almost imperceptible wear, despite heavy traffic sustained by all sections, a fact due mostly to the care taken in preparing foundations and in exercising "stitch-in-time" maintenance methods.

Coefficient of Roughness for Drainage Ditches

Photographs Aid Selection of Values for Proposed Channels—Tests Show Actual Values for Varying Conditions

A WIDE range in the roughness coefficient for the Kutter formula, as applied to flow in existing drainage channels, and a suggested use of photographs or pictures to assist in the selection of the coefficients for proposed channels of this kind, are the main points of a recently published report on the flow of water in dredged drainage ditches by C. E. Ramser, senior drainage engineer, U. S. Department of Agriculture.

To determine the value of the coefficient of roughness n in the Kutter formula under the conditions existing in dredged ditches an extended series of observations has been conducted at different points in the central, south and southwest sections of the country. The minimum values thus obtained range from 0.0128 to 0.0253 and the maximum values from 0.0550 to 0.1620. The extremely low figures of 0.0128 and 0.0140 were obtained in Iowa and are attributed mainly to the lining of the channels with a slimy and slippery mud which reduced the friction materially. The excellent condition and uniformity of section of the channels were minor factors in the result. The excessively high figures of 0.1500 to 0.1620 were obtained in Tennessee, in a crooked channel having irregular slopes and bottom, caving sides, trees and bushes on the slopes and logs and drift on the bottom. A close second to this record was obtained in Florida, with values of 0.1400 and 0.1080 in a straight stretch of ditch having the channel practically covered with vegetation.

All the channels were in alluvial ground and the report states that no noticeable difference was detected in the retarding effect of different kinds of soil. In the study of the ditches, irregularities of sides and bottom were noted separately, as the bottom alone is often the chief cause of retardation during low stages of water. Growth of vegetation checks erosion and promotes silting, but on the other hand active erosion checks and often prevents such growth. It is pointed out that with erosion in a new and well-finished dredged channel the roughness coefficient increases, but that the flow capacity also increases, since the enlarged cross-section more than offsets the retarding effect of the higher coefficient.

On the basis of investigations Mr. Ramser concludes that in designing a dredged channel a value of 0.030 for n should be used if the channel is to be dredged smooth and 0.035 if it is to be dredged roughly. When these values are used the channels should be maintained carefully. If it is known that they will be neglected the value should be selected in accordance with the worst conditions anticipated. When it is known that a soft mud lining will exist and that the channels will be maintained in good condition a somewhat lower value of n may be employed.

Other conclusions as to dredged channels may be summarized as follows: (1) A deposit of slimy silt on the sides and bottom greatly reduces frictional resistance to flow; (2) clearing of perennial growth will increase the flow capacity greatly; (3) summer growth of grass and weeds decreases the capacity greatly, the same being true of accumulation of drift trees and logs; (4) after a certain amount of erosion further erosion may not increase the roughness; (5) the roughness coefficient is appreciably higher for a roughly dredged channel; (6) the hydraulic efficiency deteriorates quickly unless the channel is maintained systematically; (7) abrupt variations in cross-section reduce the hydraulic efficiency of a channel.

As to the use of photographs and pictures in selecting a value of n for a proposed channel, Mr. Ramser points out that the engineer who has had a wide personal observation of conditions in channels for which values have been determined is generally qualified to select a proper value for a new channel. But the engineer who has not had similar experience may get material assistance from views and descriptions of existing channels for which values have been determined by experiment. For this reason the report is accompanied by numerous views and careful descriptions of the channels in which flow observations have been made. By comparing the relative conditions and values the engineer may guide his judgment in selecting a proper roughness coefficient for the probable or expected condition of a proposed channel.

Montreal Bridge Fire Starts Discussion of Tunnel and Bridge Projects

Following the roadway fire on the Victoria bridge at Montreal on Aug. 21, 1920, the dependence of the city and in fact of the entire north bank of the St. Lawrence River on this single crossing became painfully apparent. The fire, cause unknown, started in the wood flooring of the highway deck and traveled along the bridge quite rapidly. By the efforts of the Fire Department, aided by rain, the flames were kept from the adjacent railway and electric car tracks, but about half a mile of the vehicle roadway was completely destroyed.

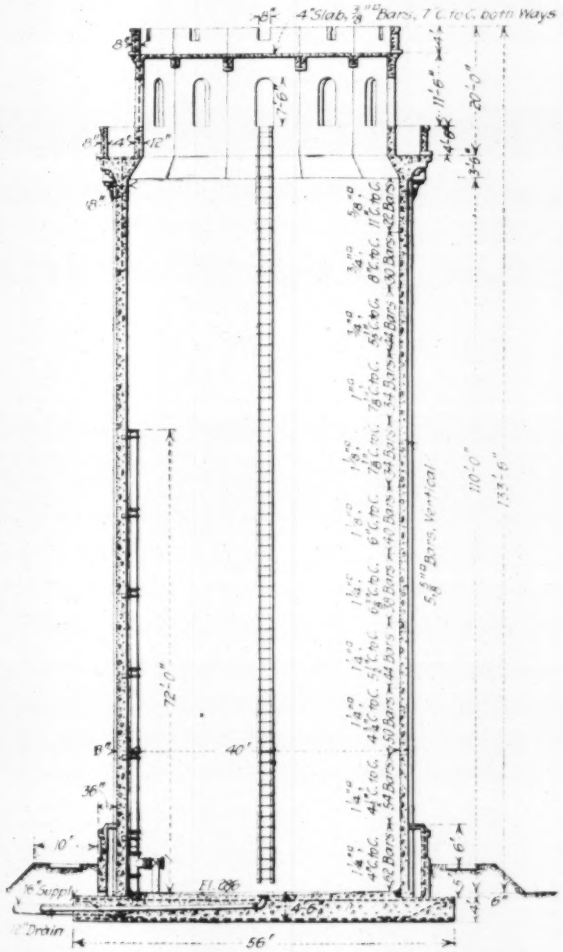
Thousands of motor cars had to seek passage to the city by ferry boat at Longueil, three miles away, during the period that the bridge roadway was interrupted. As this ferry accommodated only a small number of cars, some had to wait as much as ten hours to make the crossing. The prices of garden produce in Montreal increased by about 30 per cent, as most of the produce comes from the other bank of the river. Tourists carried away the bad news of the traffic conditions at the ferry crossing, and in this way Montreal had some gloomy advertising. The isolated position of Canada's metropolitan city was for almost the first time clearly realized. The Victoria bridge is the only highway bridge across the St. Lawrence River. As a result of the accident, already two bridge projects and one tunnel project are under discussion. While the great cost of constructing any such works is likely to make this talk end without results, the present attitude of the Montreal people may be stated as being strongly in favor of improving the highway connection between the two banks of the river.

Concrete Standpipe for 110 Ft. Head at Kansas City

With 40 Ft. Diameter Has a Capacity of 1,000,000 Gallons—Top Is 134 Ft. Above Ground—Has Joint at Base

By T. D. Samuel, Jr.
Chief Draftsman, Kansas City, Mo., Water Department

ONE of the largest reinforced-concrete standpipes ever attempted has just been completed for the Kansas City, Mo., water department in the southwest part of the city. It is 40 ft. in diameter and rises 133 ft. 6 in. above the surface of the ground at its base but it is designed to take water up to the 110 ft. elevation. This gives a capacity of 1,000,000 gal. The distinguishing features of the structure are that there is a joint between shaft and base and the shaft was



VERTICAL SECTION THROUGH KANSAS CITY CONCRETE STANDPIPE

carried up to the top as a continuous concreting operation.

The residential district the standpipe serves is some four to seven miles distant from the Turkey Creek Pumping Station, and comprises approximately seven square miles. Within this district are points whose ground elevations are the highest in the city and which could not be supplied with sufficient water pressure from the Turkey Creek Station during the hours of heavy consumption. In order to relieve this situation, the Board of Fire and Water Commissioners decided to construct a standpipe upon the highest point available. Accordingly the Board asked for and received bids on the design and construction of a reinforced-

NEW CONCRETE STANDPIPE FOR KANSAS CITY WATER WORKS

concrete stand pipe with a capacity of 1,000,000 gal. and a water level of 110 ft. above the ground surface at the site selected.

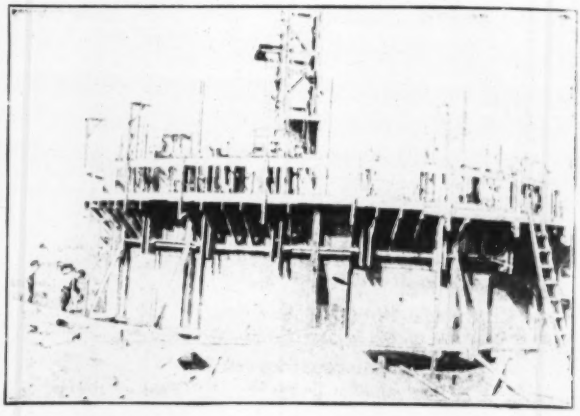
Among the bids received was a general design submitted by the Tifft Construction Co. of Buffalo, N. Y. This design was approved by the Board and the right to use it was purchased from the Tifft company. The Engineering Division of the Water Department completed all detailing of the plans, drew up specifications and advertised for bids. Contract for constructing the stand pipe was awarded to the Finton Construction Company of Kansas City for $50,000.

The district served by the standpipe is regulated by check valves placed on all fed lines running into the district and the height of water within the stand pipe controlled by an altitude valve.

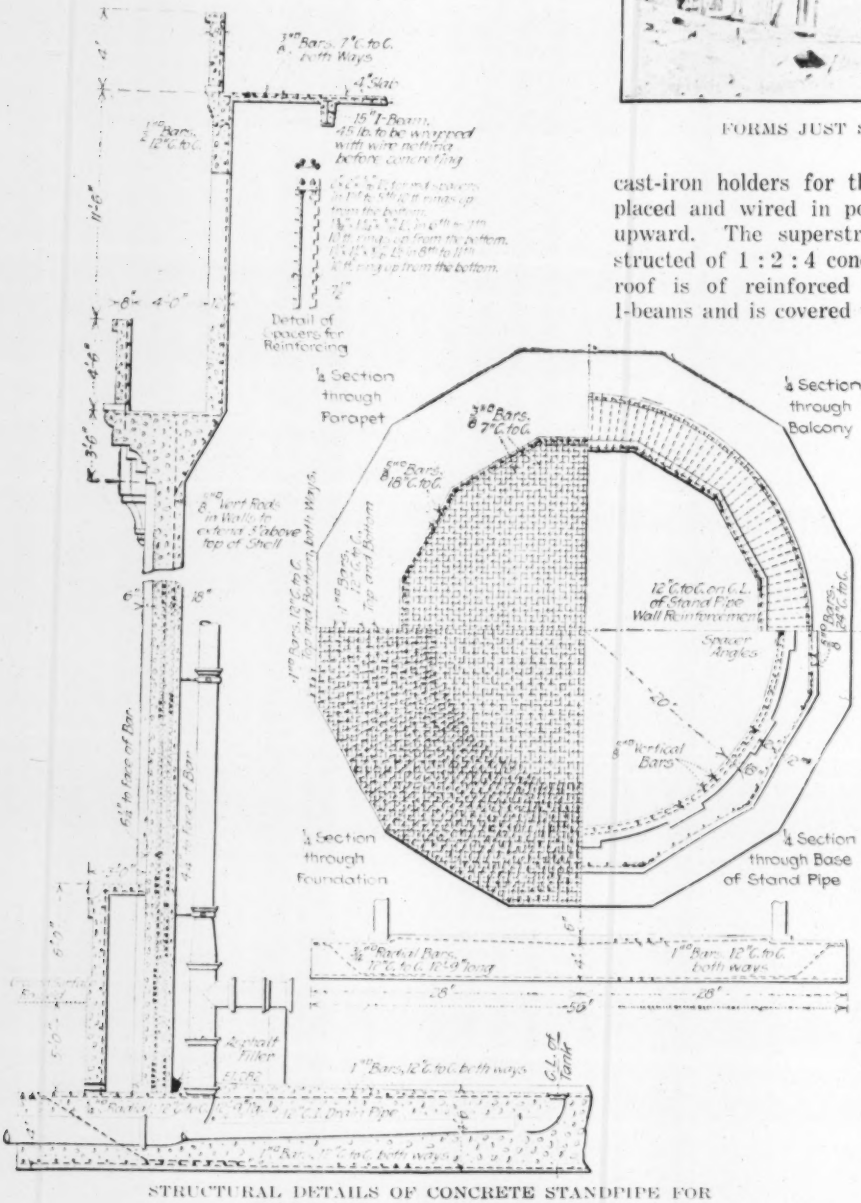
The foundation or base is a 12 sided slab of reinforced concrete 4 ft. thick, with an inscribed diameter of 56 ft. Reinforcement consists of 1-in. square bars in top and bottom running both ways and ¾ in. square radial bars around the outer portion. Concrete consisted of a 1 : 2 : 4 mixture and was poured in one continuous operation. A recess, whose surface was troweled to a true and smooth finish, was left at the top of the foundation to receive the walls of the stand pipe. A 16 in. cast-iron inlet pipe and a 12 in. cast-iron drain were placed within the foundation. The top of foundation was sloped 6 in. to the center to provide drainage.

The main wall is 18 in. thick throughout its entire height of 110 ft., except for the base which is

flared out. The internal diameter is 40 ft. and there are 12 ribs or pilasters 6 in. thick and 4 ft. wide on the outside of the walls for ornamental purposes. These ribs were poured integral with the wall. Reinforcement within the walls is of circumferential square bars varying in size from 1¼ in., 4 in. c. to c., for the bottom 10 ft. to ⅞ in., 11 in. c. to c. for the top 10 ft. In addition notched angle irons 12 ft. c. to c. are used as guide bars for the horizontal rods and vertical ¾ in. square bars spaced 2 ft. c. to c. placed between them. A 1:1½:3 mixture was used in the main wall.



FORMS JUST STARTING FROM BASE



STRUCTURAL DETAILS OF CONCRETE STANDPIPE FOR 110-FT. HEAD AND 40-FT. DIAMETER

Forms for the erection of the walls were built in a ring section, fitted with jacks and jack rods to provide for a continuous sliding form. The operation of pouring was continuous throughout and the pouring was so timed that newly mixed concrete was placed upon concrete which had not yet reached its initial set and yet permitted the forms being moved. Threaded cast-iron holders for the ladders and inlet pipe were placed and wired in position as the work progressed upward. The superstructure and balcony were constructed of 1 : 2 : 4 concrete and were monolithic. The roof is of reinforced concrete with structural steel I-beams and is covered with 5 ply tar and gravel. The ornamental base was poured after the walls of the stand pipe had been completed.

In the concrete, portland cement mixed with clean sharp Kaw River sand and broken limestone of a size that the largest piece would readily pass a 2 in. ring and the smallest a ¼ in. ring were used. Reinforcing bars were of open-hearth high-carbon steel rolled from new stock with a tensile strength of not less than 85,000 lb. per square inch and an elastic limit not less than 52,500 lb. per square inch. A 40-diameter lap on all bars was used.

As the work progressed upward, the walls were cleaned of all water marks and all cavities filled with a 1:2 mortar and after the completion of the walls, the entire surface that was exposed to view was finished by rubbing in a thin coat of 1 : 2 cement mortar with carborundum bricks. The recess or groove around the bottom on the inside of the stand pipe was filled with hot asphaltum to act as a filler and keep water from passing through the joint between the walls and the foundation.

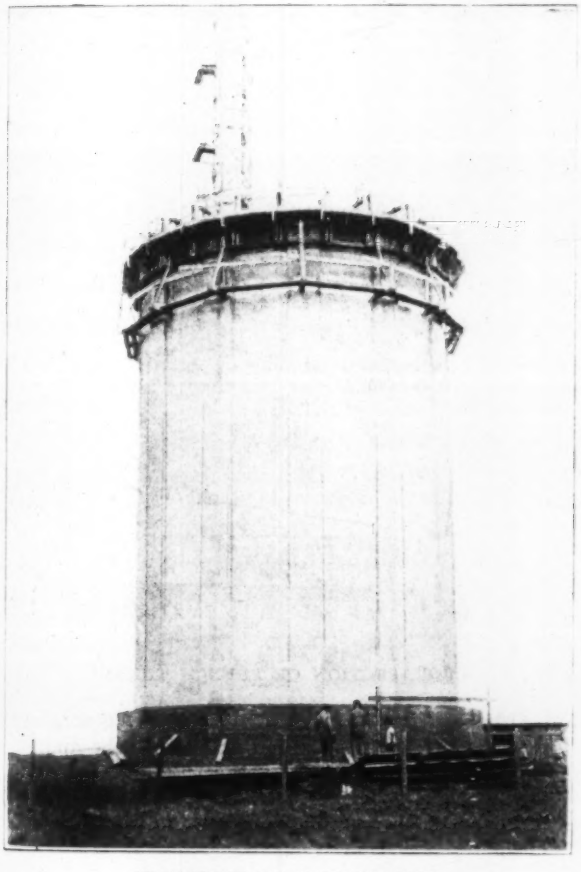
An earthen terrace with concrete walk on the top was built up around the standpipe and ornamental electric light standards set at its four corners.

No outside forms were used for the foundation, the concrete being poured in contact with the clay bank. The foundation was poured in two continuous days of 24 hours each, and the walls in 14 continuous days of 24

hours each. Work began on the excavation in July, 1919, but owing to adverse weather conditions, slowness in getting material and labor troubles, the standpipe was not completed until January, 1920.

In the computations, the tensile stresses allowed for steel were 15,000 lb. per square inch. Tensile stresses and amount of steel required in the walls were figured in the usual manner for water pressures at various depths. Computations for soil pressures were made in the usual manner. Borings at site of standpipe showed a bed of dry yellow clay over 35 ft. thick and tests of bearing power gave results of 4 tons per square foot. Three tons per square foot was allowed in figuring the required area of base.

No waterproofing of any character was used at first on the work, it being thought that the richness of con-



STANDPIPE HALF COMPLETED

crete used and the care taken in its mixing and placing would make it dense enough to be waterproof but after the standpipe had been in service several days and had had a head of water of over 90 ft. in it, several places on the walls developed slight seepage leaks. Examination disclosed that these were probably caused by laitance. The joint at the bottom also leaked and after the standpipe had been emptied this was found to have been caused by the asphaltum filler used in the recess, having hardened and contracted under a water pressure of about 50°.

The leaks in the walls were not serious from the standpoint of water wastage but on account of appearance and possible damage that might be caused this winter by frost and freezing, it was decided to waterproof the entire structure where water came in contact with the surface.

The standpipe was drained, thoroughly cleaned and dried and two coats of "Stark's Waterproof Paint and Cement Putty" applied to the outside and inside surfaces of the shell. The asphaltum filler in the recess was removed and the surface and a short distance up the side walls given a coat of "Johns Manville Concrete Primer." This was allowed to set and then a 32 in. wide 5-ply waterproofing membrane was applied. This extended up the side wall, down over the recess in the base and out over the base the balance of the width. The membrane consisted of No. 14 impregnated asbestos felts mopped in hot self-healing cement in two-ply construction. Over this was applied in one-ply construction a layer of saturated mule hide membrane and following this an additional two plies of impregnated asbestos felts mopped in self-healing cement. In the space left in the recess at the base, self-healing cement was poured while hot.

The standpipe has been in service over three months at this date and has given very satisfactory service. There has been no more leakage.

All construction work was under the direct supervision of Charles S. Foreman, first assistant engineer of the Water Department.

Zinc-Chloride Loss from Treated Ties

IN use of inorganic salts for preservative treatment of wood the effect of the preservative is likely to be reduced by its leaching out of the wood when affected by water or moisture. Experiments on this leaching action and its effect in railway ties treated with zinc-chloride, reported by Ernest Bateman, of the U. S. Forest Products Laboratory, in Bulletin No. 227 of the American Railway Engineering Association, indicates a segregation of the preservative. During wet weather leaching takes place, with the result that basic zinc-chloride is deposited in the tie. During dry weather the moisture is evaporated, thus concentrating the solution, the excess hydrochloric acid being either lost in evaporation or taken up by redissolving any basic chloride which may be present. The conclusions presented by Mr. Bateman are substantially as follows: In the leaching process the chlorine leaches faster than the zinc, part of which is left behind as an insoluble basic chloride. This indicates that the chlorine plays a very important part and that if the zinc does not have its proper amount of acid radical it loses its preserving power. In other words, as long as the zinc remains soluble it is toxic, but as soon as the insoluble basic chlorides are formed, the zinc so combined has little or no toxic action. The presence of comparatively large amounts of zinc does not insure that the wood is protected against rot unless a sufficient amount of acid radical is present. The soluble basic chlorides of zinc have little or no toxic value.

Railway Motor Car Service in Australia

A 5-ton motor truck converted into a motor car for operating the Grafton and Lismore branch of the New South Wales Government Railways has proved so successful, according to the report of the railway commissioners for the year ending June 30, 1920, that other motor cars are to be built for similar service on other branch lines.

Fast Railway Tunneling in France During the War

Single-Track Tunnel in Rock Driven and Lined in 75 Days for War Emergency—Continuous Work in Eight-Hour Shifts

RAPID progress in tunneling was accomplished by the Northern Railway of France in 1918 as part of the work of doubletracking a section of the line between Paris and Treport to form an alternative to a route threatened by the enemy. The progress averaged 16 ft. per day of single-track tunnel, lined and ready for traffic. At Marseille-en-Beauvaisis there were two single-track tunnels 180 and 600 ft. long, separated by an open cut 66 ft. deep and 260 ft. long. Widening these tunnels was out of the question, as the existing line was handling heavy traffic.

The new tunnel for the second track had to be nearly 1,200 ft. long, as the great amount of excavation from a large cut corresponding to that on the old line could have been removed only through the southern section of the new tunnel and would have delayed materially the work whose speedy completion was of the utmost importance. The line is on an ascending grade of 0.6 per cent to the north. About 577 ft. of the southern end of the tunnel is on a curve having a radius of 1,640 ft., with a parabolic transition curve in the track. The tunnel was in a badly fissured chalk formation and was located with its center line about 60 ft. from that of the old tunnel in order that it might be considered in solid ground where it paralleled the open cut and that its construction would not affect the stability of the existing work. The section, shown in the accompanying drawing, is identical with that of the old tunnel, but its lining is of concrete instead of brick. In the curved portion the thickness of lining is 24 in. instead of 14 in. Recesses or refuges for the section men are provided on the west side at intervals of 80 ft.

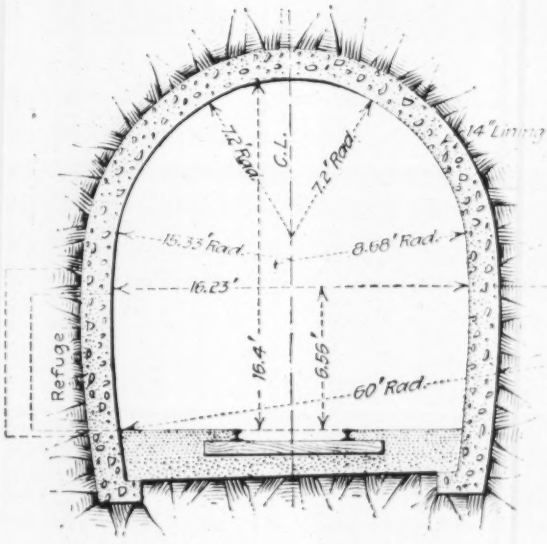
Method of Lining

Work was commenced simultaneously at both ends, the first step being a bottom heading on the center line. As soon as this had advanced about 65 ft. a top center heading was started, holes being broken through its floor to allow of discharging the rock into cars on a portable construction track of 24-in. gage in the bottom heading. This excavated material was used to form the approach fills at the ends of the tunnel. As soon as the top heading had advanced sufficiently a third gang widened the top heading and cut side trenches for the seats of the arch lining. A fourth gang erected the centers and a fifth gang placed the concrete. This lining rested partly upon the rock and partly upon sills to be supported later by heavy posts.

Transverse struts having been placed to brace the arch at the springing line, the widening of the bottom heading was undertaken to place the side walls, the arch being underpinned by heavy inclined posts at 6½-ft. intervals. As soon as these posts were placed excavation was stopped and the footings for the walls were built. Curved ribs for the forms were then spiked to the posts and the concrete for the side walls was placed. The side walls were built in sections separated by piers of solid rock, which were not excavated until the concrete had set. With this arrangement the arch was supported by underpinning for only short lengths, so that there was no fear of settlement and no necessity of taking observations for settlement.

At the north end a main highway crosses the tunnel with very little cover. On account of the traffic of heavy artillery and motor trucks it was necessary to establish a temporary bridge to carry the load over the tunnel roof. At the south end, an aqueduct 5 ft. wide had to be extended and carried on difficult foundations.

The material encountered was such as to permit of rapid progress, but it soon began to disintegrate on exposure to the air, which necessitated heavy timbering and almost continuous sheeting. One of the great difficulties was to procure a sufficient supply of timber in the short time available. From April 20 to May 20, 1918, a force of 240 workmen was engaged on the preliminary work of leveling and locating the line, installing the camp, arranging for the supply and storage



CROSS-SECTION OF FRENCH TUNNEL

of provisions and materials, placing the construction tracks on the approaches and excavating the approach cut.

Tunneling was commenced May 21, 1918, and the railway company undertook to have the work completed and the line ready for traffic in 100 days from that date. The bottom headings met on June 28 and the top headings on July 4. All the masonry was completed by Aug. 2, and tracklaying and ballasting by Aug. 4, or only 75 days after the commencement of the work. On Aug. 6 the line was put in operation. Miners from districts invaded by the Germans composed the greater part of the forces, which numbered 520 men from May 21 to July 6, when the number was increased to 630. The work proceeded continuously, the men working in three 8-hr. shifts. A contract was let to Fougerolle Brothers, of Paris, and construction was under the direction of Mr. Aumont and Mr. Candlier, engineers for the Northern Railway, with Mr. Petit as engineer in charge. The above description is from an article in the *Révue Générale des Chemins de Fer* by Mr. Moutier, assistant superintendent.

Standard Method of Recording Construction Accidents

Argument and Instructions for Compiling Accident Statistics Formulated by the Construction Section of the National Safety Council at Recent Annual Congress

THE following data form a report presented by the Statistical and Standardization Committee of the Construction Section, National Safety Council, at the recent annual congress of the Council held in Milwaukee, Wis. The members of the committee are F. C. Davidson, Dwight P. Robinson & Co.; F. S. Robinson, Detroit General Builders' Association; and J. E Griffith, E. I. Du Pont de Nemours & Co.:

The keeping of systematic records is of the greatest assistance in preventing accidents and is a fundamental factor in effective safety work:

(1) By showing executives the number and the causes of accidents and enabling them to grasp clearly the waste and loss of efficiency which accidents represent. Only when the facts regarding accidents are presented in an exact, concise form instead of in a vague general way, can a busy executive be reasonably expected to realize fully the importance of the accident problem and its bearing upon the well being of his employees and the productiveness of his business.

(2) By showing operating executives and safety men where accidents are occurring and from what causes, so that they may know where to concentrate their efforts for prevention.

(3) By attracting the attention of foremen and workmen, and stimulating rivalry between different organizations or between different divisions or groups in the same organizations, so that superintendents, foremen, and workmen will strive to produce a record with respect to accidents which will compare favorably with other divisions and with their own past record.

Value of Accident Statistics

As a matter of fact in the field of accident prevention as a whole, not much headway was made in reducing the frequency of accident occurence until accident statistics were collected which showed the causes responsible for the greater number of accidents, and directed effective prevention measures. The concerns which have been most successful in securing the interest and co-operation of executives, foremen, and workmen in accident prevention, are practically without exception those which have a satisfactory system of recording accidents and who have devised means for presenting these records in an interesting form.

A uniform method of compiling accident statistics should be adopted by all members of the Construction Section:

(1) It enables members to compare their various accident records and lets each individual member know how his record compares to others.

(2) It stimulates friendly rivalry between different members to achieve good accident records.

(3) Having the accident records of all members on a common basis enables the combined experience of all members to be analyzed in a scientific manner: (a) Thus, in a very much shorter time than if each depended solely on his individual data, the principal hazards in the whole construction field can be fairly definitely determined; (b), this makes it possible for all to devote their energies to the solution of the most urgent accident problems in the construction field, and to exchange ideas and experiences to the most useful advantage; (c), it affords a sound basis for concerted action by the Construction Section in such possible ways; as assisting in the preparation of standard codes or in bringing pressure upon manufacturers of construction equipment to induce them to guard their devices at the source; (d), it makes it possible for valuable special studies to be made in correlating accident statistics with other phases of construction work, such as endeavoring to determine whether or not any definite relation exists between accidents and such other factors as overtime work, night work, labor turnover, labor unrest or special types of construction.

Reporting Accidents

Every accident, large or small, that causes any sort of personal injury, serious or trivial, whether or not it requires any medical expenditure should be reported and made a matter of record on a printed form provided for that purpose. The reason is that in the case of every accident there is a possibility of subsequent complications such as a serious infection. Consequently, it is advisable to have available the essential data relating to the case, such as the name of injured and the time, place, cause and nature of the injury. There are various satisfactory systems for obtaining a formal report of every accident; some of the methods in use are:

(1) The foreman makes out a report of every accident on a prescribed form. One copy of this report is kept on file in the field office and one copy is sent to the home office.

(2) Where there is a medical station or field hospital on the job, a record of every injury is made there.

(3) Where there is a safety department on the job, a report of every accident is made by this department.

(4) One of the most advantageous methods is to use the standard state accident report forms prescribed by the state authority administering the compensation law in any particular state. Since at the present time almost all the states have compensation laws and most of them require a report on all accidents, it saves duplication of effort if the forms of the particular state in which the job is located are used for reporting accidents. A certain individual on the job, a clerk, or a first-aid man can be designated to see that every accident is reported properly and promptly on the state accident blanks. A copy can be kept on file in the job office and a copy can be sent to the home office.

FORM 1 FOR USE BY FOREMEN FOR REPORTING ACCIDENTS

FOREMAN'S REPORT OF ACCIDENT

Name: Check No.
Occupation:

Date injured: Hour of Day: A.M. P.M.
Weather conditions at time of accident:
Place where accident occurred:

Injured person's immediate superior:
Where was he at time of accident?
Had employee been instructed in the work? By whom?
Machinery, tool or appliance (if any) involved?
Is it in good condition? Was safeguard provided?
Describe in full how accident happened:

Nature of injury:
Disposition made of injured:
Witnesses to accident or names of persons with knowledge of accident?
What can be done to prevent a similar accident:

Date 192 Foreman:

(5) Form 1 is for use by foremen in reporting accidents and indicates the type of essential facts which should be made a matter of record in the case of every accident.

For statistical purposes the following have been adopted for standard definitions:

Tabulation Accidents, Diseases and Injuries—All accidents, diseases and injuries arising out of the employment and resulting in death, permanent disability, or in the loss of time other than the remainder of the day, shift or turn on which the injury was incurred should be classified as tabulatable accidents, diseases and injuries. Tabulatable accidents are commonly called "Lost Time" accidents, although

the former term is preferable due to the fact that in the use of the latter term there is danger that the idea might be conveyed that the occasional permanent partial disability with no lost time connected with it is not to be counted. Tabulatable accidents are the only accidents which should be used for comparative or publicity purposes.

Reportable Accidents, Diseases and Injuries—These include all tabulatable or "Lost Time" accidents, diseases and injuries and all non-tabulatable or "No Lost Time" accidents, diseases and injuries.

Compensable Accidents, Diseases and Injuries—These, as used in any report in accordance with the practice in any particular state, should be shown separately and clearly defined.

Permanent Total Disability—To this group should be assigned every accident, disease, or injury which is designated by statute as permanent total disability or which permanently incapacitates the workman from performing any work continuously in any gainful occupation.

Permanent Partial Disability—To this group should be assigned every accident, disease or injury (less than permanent total disability) which results in the loss of, or in the permanent impairment of any function of the body.

Fatal and Non-Fatal—For statistical purposes, all accidents or injuries are to be considered non-fatal which do not terminate in the death of the injured employee within twenty-eight days of the date on which the injury was sustained. No subsequent correction of the original tabulation requires to be made of non-fatal injuries as thus defined which terminate fatally after more than twenty-eight days of the date on which the injury was sustained.

Days Lost Time—Days lost time due to accident should be expressed in terms of working days. Sunday is not to be counted as a working day. Saturday should be counted as a full day, even though only a half day is worked. Calendar days can be converted into working days by multiplying by 6/7.

Accident Rates

The basis of all accident rates is necessarily the number of men exposed to the risk of accident.

It is absolutely necessary to have a common unit for measuring accidents in all occupations, all industries, and all states or countries. Therefore, it is recommended that all members of the Construction Section adopt the unit of 1,000 hr. exposure or 1,000 working man-hours as the basis for calculating all accident rates. This unit has been adopted by the U. S. Dept. of Labor Statistics and endorsed by the International Association of Industrial Accident Boards & Commissions and by many leading members of the National Safety Council.

There are two fundamental kinds of accident rates which it is recommended that all members compute: (a) Accident Frequency Rates. (b) Accident Severity Rates.

An accident frequency rate is an expression stating the number of tabulatable or lost time accidents occurring in a specified period of time per given number of 1,000 man-hour units of exposure. The accident frequency rate is generally stated as the number of tabulatable, or lost ti accidents per hundred 1,000 man-hour units of exposu (per 100,000 man-hours worked) or per thousand 1,000 ma hour units of exposure (per 1,000,000 man-hours worke

Method of Computation—The number of tabulatable lost time accidents occurring in any given period are kno from the accident reports. The number of man-hou worked during the given period are known from the regul records of any company. Hence, the accident frequen rate for the given period is obtained by dividing the nu ber of tabulatable or lost time accidents by the actual nu ber of 1,000 man-hour units of exposure. The quotient re resents the number of lost time accidents per 1,000 ma hour units of exposure or per each 1,000 man-hours worked The accident frequency rate for the period is stated eithe as the number of tabulatable or lost time accidents pe

FIG. 1—FORM FOR COMPILING ACCIDENT FREQUENCY RATES

Jobs or Depts.	No. of Man-Hours Worked	No. of Tabulatable or Lost Time Accidents							Frequency Rate: Accidents per 1,000,000 Man-Hours Worked
		Total	Deaths	Permanent Total Disabilities	Permanent Partial Disabilities	Temporary Disabilities			
						Over Two Weeks	Over One to Two Weeks	One Week and Under	
Total									

The accident frequency rate is stated as the number of tabulatable or lost time accidents per hundred 1,000 man-hour units of exposure (per 100,000 man-hours worked) or per thousand 1,000 man-hour units of exposure (per 1,000,000 man-hours worked).

Method of Computation—The number of tabulatable or lost time accidents occurring in any given period are known from the accident reports. The number of man-hours worked during the given period are known from the regular records of any company. Hence, the accident frequency rate for the given period is obtained by dividing the number of tabulatable or lost time accidents by the actual number of 1,000 man-hour units of exposure. The quotient represents the number of lost time accidents per 1,000 man-hour units of exposure or per each 1,000 man-hours worked. The accident frequency rate for the period is stated either as the number of tabulatable or lost time accidents per 100,000 man-hours worked or per 1,000,000 man-hours worked.

A concrete example to illustrate the method of computing the accident frequency rate is as follows: The Atlantic Construction Co. in the month of May had occur on their construction jobs a total of 10 tabulatable or lost time accidents. The total number of man-hours worked on the jobs of the Atlantic Construction Co. during the month of May was 179,880, which is equivalent to 179 1,000 man-hour units of exposure. Therefore divided 10 × 179.88: the quotient is 0.056 which represents the number of lost time accidents per each 1,000 man-hour units of exposure, or per each 1,000 man-hours worked. The accident frequency rate of the Atlantic Construction Co. for the month of May is, therefore, stated either as 5.6 tabulatable or lost time accidents per 100,000 man-hours worked, or as 56 tabulatable or lost time accidents per 1,000,000 man-hours worked. A sample form recommended for use in tabulating accident frequency rates is shown by Fig. 1.

The purpose of accident severity rates is to compare the relative seriousness of accidents. The only stable, convenient and satisfactory basis for measuring the relative seriousness of various accidents is by the time lost. An accident severity rate is an attempt to express in a standard way the economic cost of industrial accidents in terms of time lost.

An accident severity rate is an expression stating the number of working days lost per each 1,000 man-hour units of exposure (or 1,000 man-hours worked) due to the tabulatable or lost time accidents occurring in a given period.

Method of Computing—The number of working days lost due to the accidents occurring in the given period are known in the case of all temporary disabilities.

Furthermore, the number of fatalities, permanent total disabilities and also the number and degree of the permanent partial disabilities occurring in the given period are known. In order to derive an expresion in the form of a rate the fatalities and permanent disabilities must be taken into account. Therefore, for statistical purposes, to each fatality and permanent disability must be assigned arbitrary figures representing an equivalent number of days lost. The table of equivalents which is used by the U. S.

FIG. II—FORM FOR COMPILING ACCIDENT SEVERITY RATES

Jobs or Depts.	No. of Man-Hours Worked	Days Lost Due to							Severity Rate Days Lost per 1,000 Man-Hours Worked
		Total Days Lost	Death	Permanent Total Disabilities	Permanent Partial Disabilities	Temporary Disabilities			
						Over Two Weeks	Over One to Two Weeks	One Week and Under	
Total									

Department of Labor Statistics, the International Association of Industrial Accident Boards and Commissions, the National Safety Council, and others is shown in Table 1.

The number of days lost due to the temporary disabilities is added to the number of days obtained by taking the equivalents of the fatalities and permanent disabilities and thus the total days lost due to the accidents occurring in the given period are known.

TABLE I—SCALE OF TIME LOSSES FOR DEATHS AND PERMANENT DISABILITIES

(Its use is advocated by the International Association of Industrial Accident Boards and Commissions and by the United States Bureau of Labor Statistics)

Nature of Injury	Degree of Disability in Percent of Permanent Total Disability	Days Lost
Death	100	6,000
Permanent total disability	100	6,000
Arm above elbow, dismemberment	75	4,500
Arm at or below elbow, dismemberment	60	3,600
Hand, dismemberment	50	3,000
Thumb, any permanent disability of	10	600
Any one finger, any permanent disability of	5	300
Two fingers, any permanent disability of	12½	750
Three fingers, any permanent disability of	20	1,200
Four fingers, any permanent disability of	30	1,800
Thumb and one finger, any permanent disability of	20	1,200
Thumb and two fingers, any permanent disability of	25	1,500
Thumb and three fingers, any permanent disability of	33⅓	2,000
Thumb and four fingers, any permanent disability of	40	2,400
Leg above knee, dismemberment	75	4,500
Leg at or below knee, dismemberment	50	3,000
Foot dismemberment	40	2,400
Great toe or any two or more toes, any permanent disability of	5	300
One toe, other than great toe, any permanent disability of	00	
One eye, loss of sight	30	1,800
Both eyes, loss of sight	100	6,000
One ear, loss of hearing	10	600
Both ears, loss of hearing	50	3,000

Notes. (1) Injuries not involving amputation should be rated as a proportion of the weight assigned to the entire loss of the member involved, in accordance with the degree of impairment. (2) The weighting for impairment of function of any member should be such percentage of the weighting for dismemberment as may be determined by the adjudicating authority in fixing the compensation for such impairment—*i.e.*, if loss of an arm is compensated by 240 weeks indemnity, then an impairment of the arm for which 160 weeks compensation was paid, should rate as two-thirds of the loss of the arm in the above scale. (3 Hernia should be included only as a temporary disability on the basis of the actual time lost.

The number of man-hours worked, or hours of exposure, during the given period are known from the regular records of any company.

Hence the accident severity rate for the given period is obtained by dividing the total days lost by the actual number of 1,000 man-hour units of exposure. The quotient represents the number of days lost per each 1,000 man-hours worked. This figure is stated as the accident severity rate for the given period.

A concrete example to illustrate the method of computing the accident severity rate is as follows:

The Atlantic Construction Co., as cited above, during the month of May had occur on their construction jobs a total of ten tabulatable or lost time accidents; seven of these ten accidents were temporary disabilities, one was fatal, one caused permanent disability and one resulted in the loss of the man's finger, which is a permanent partial disability.

The total number of days lost is determined as follows:

No.	Kind	Days Lost
7	Temporary disabilities	88*
1	Fatal	6,000†
1	Permanent total disability	6,000†
1	Permanent partial disability (one finger lost)	300†
10	Accidents	12,388

* From the actual records of the time lost by the individual injured men, supplemented possibly in some cases, where an individual has not returned to work at the time of compiling the record by an estimate as to the time lost by an expert industrial physician.

† From Table I of Equivalents.

The total number of man-hours worked on the jobs of the Atlantic Construction Co. during the month of May was 179,880, which is equivalent to 179.88 1,000 man-hour units of exposure.

Therefore, divide 12,388 by 179.88. The quotient is 68.9, which represents the number of days lost per each 1,000 man-hour unit of exposure.

Hence the accident severity rate of the Atlantic Construction Co. for the month of May is stated as 68.9 working days lost per 1,000 man-hours worked. A sample form recommended for use in tabulating accident severity rates is shown in Fig. 2.

Heavy Truck Traffic Under Special Conditions on English Roads

An article on Essex roads and bridges, in *Surveyor and Municipal and County Engineer of* August, 13, 1920, tells of extra-heavy road traffic during or after the railway strike of September, 1919. The following quotations from the article indicate the extent of damage to bridges and of necesasry repairs.

"Statistics taken in November, 1919, show that on one occasion about 2 a.m. a fleet of thirty-nine loaded lorries, representing 585 tons, passed an observation post on the Chelmsford-Colchester road at intervals of 45 seconds; this is mentioned as a sample of what this road was subjected to in the autumn and early winter of 1919. The road is now carrying approximately 2,000 tons per day.

"The strain of heavy motor lorry traffic succeeding the railway strike has been very apparent upon the old county bridges on certain main roads, and Mr. Sheldon predicts a large expenditure in dealing with the damage already done. On the London-Ipswich road an important iron bridge at Widford near Chelmsford gave way at the abutment in March last and a temporary bridge had to be constructed at a cost of approximately £2,000, while the new bridge when built will probably cost £10,000. Upon the section of the same road lying between Chelmsford and Brentwood a careful examination disclosed that three brick bridges, each about 100 years old, had been seriously damaged since August, 1919, and extensive repairs and strengthenings were immediately necessary. Seeing that the great majority of the county bridges are from 100 to 150 years old, brick built, and were designed and built or strengthened to take coach traffic prior to railways, it is regarded as extraordinary that with present-day traffic they are standing as well as they are."

Experimental Sewage Irrigation Plant in Florida

Filter Effluent Pumped to Field — Discharge of Risers on Pipe Laterals Controlled by Automatic Float Valves

By F. E. Staebner
Drainage Engineer, U. S. Bureau of Public Roads, Washington, D. C.

IN THE spring of 1919, by arrangement with the Bureau of Public Roads and the Florida Agriculture Experimental Station, a plant to utilize the sewage from the University of Florida was built at Gainesville, Fla., under the direction of the writer. The former disposal plant of the university is retained, consisting of a septic tank and broken stone filter bed. The septic tank gives a rather clear effluent and this is discharged onto the filter bed through four aerating sprays, these discharges being controlled by an automatic siphon and occurring at intervals of about 30 minutes during the daylight hours. The layout of the plant is shown by Fig. 1.

In the outlet from the filter bed a diversion box was

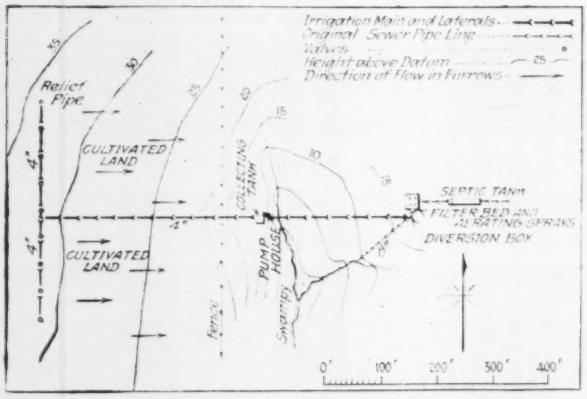


FIG. 1. SEWAGE IRRIGATION ON FLORIDA EXPERIMENTAL FARM

built to deliver the water to the new irrigation field or to waste it to the small creek as formerly. As it is intended to use the field for the continuous disposal of the sewage as well as for the growing of crops the effluent is sent through the irrigation system all the year, except when the pumping plant requires an occasional shutdown. In normal operation the water runs by gravity from the filter bed to the diversion box and thence through an inverted siphon to a reinforced-concrete collecting tank, from which it is pumped by a motor-driven centrifugal pump to the irrigation field 400 ft. away. The water is discharged successively through any one of eight automatically operated valves to a small head ditch at that valve, from which it flows over wooden weirs into the furrows between the crop rows. Corn, sorghum and Japanese cane form the 1920 crops.

The diversion box, Fig. 2, is 3 ft. square inside, with two diversion walls and an 8-in. irrigating valve, so arranged that with the valve open the sewage discharges through the old 8-in. terra cotta waste line. With the valve closed the sewage rises and flows over

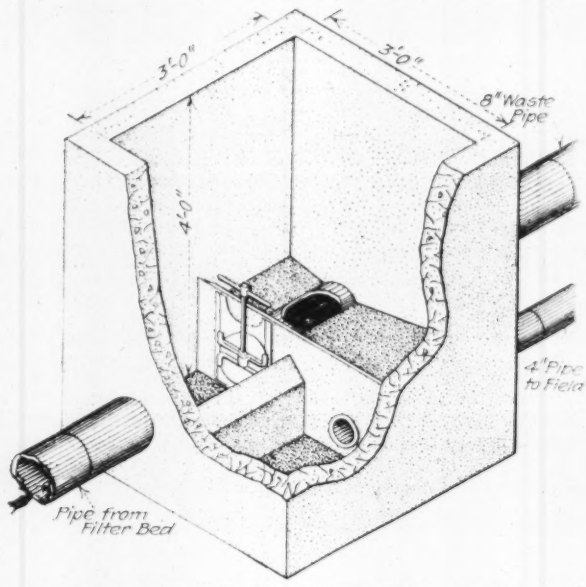


FIG. 2. DIVERSION BOX FOR SEWAGE FLOW

the first diversion wall into a side compartment, from which it flows into the 4-in. terra cotta inverted siphon which takes it to the collecting tank. The second diversion wall serves simply to allow an overflow when the 4-in. line cannot handle the flow, as during heavy storms, the excess passing over the second diversion wall and into the 8-in. waste line. The inverted siphon, 350 ft. long, passes under a small brook and may have a maximum head of about 12 ft. A clean-out plug is located at its lowest point. The concrete collecting tank is 20 x 14½ ft. and 5 ft. deep inside.

An electric control switch automatically operated by a float at selected heights of water starts and stops the 3-hp. motor which is direct connected to a horizontal centrifugal pump. No check valve is used, and at the end of each pumping period the water in the pipes is allowed to run back through the pump into the tank. A 4-in. terra cotta pipe carries the water to the high side of the field to be irrigated. The lowest part of this line is reinforced with concrete and wire up to such a point that the maximum head on the unprotected pipe does not exceed 10 ft. A 4-in. lateral leads to the north and south from the end of the main, along the high side of the field, the surface of which slopes downward in a general easterly direction, as shown in Fig. 1.

In the pipe laterals, which are 50 ft. apart, are placed 8-in. terra cotta riser pipes for the delivery of the water above the ground surface. In each riser is an automatic irrigation valve operated by a float. When the pump starts and water enters the line the float rises and causes a ratchet wheel to revolve. Ordinarily the rising of the float closes the valve and prevents the outlet of water. But after the proper number of closures the ratchet wheel, through an attached crank, draws into position a stop which prevents the closing of the outlet and leaves a free water discharge. It is necessary that the valves in the series be properly synchronized. The valves are designed with a capacity of 100 gal. per minute under normal conditions. Fig. 3 shows one of these valves.

From the valve the water spills over into a head ditch, 50 ft. long, 18 in. wide and 8 in. deep, there being one ditch for each valve. Boards with notches about 2 in. deep and 4 in. wide are placed at each furrow and brought to such position as to give equal flow

FIG. 3. AUTOMATIC SEWAGE IRRIGATION VALVE

in each of the 13 furrows leading away from any one valve. One setting of these weir boards suffices for the season. The water runs a distance of from 175 to 350 ft. down the furrows, according to the dryness of the land. The soil is sandy loam and tends to be very dry.

Four valves are now in use, and it was found that the water available was insufficient to properly irrigate the full field in dry times. During the academic year about 25,000 to 30,000 gal. per day are discharged on the 1.6 acre that have been irrigated, and a thoroughly sanitary disposal has been secured. It requires only the changing of the valve adjustments to bring the other four valves into action and another area of 1.6 acre under irrigation. The plant was not in regular operation until July, 1919, which was too late to show much effect on that season's yield.

Large Area Desirable

For sewage irrigation it is not desirable in general to dispose of the sewage on as small an acreage as possible, but rather on as large an acreage as is available. With this plant it is epected to irrigate the whole 3½ acres available. Other experiments have seemed to indicate that allowing the sewage water to run down every other furrow is as effective agriculturally as allowing it to run down every furrow, so that twice the number of plants may be fertilized and twice the area supplied with a given quantity of sewage.

During the greater part of the past year the pump operated about once every two hours and discharged a little over 2,000 gal. at each pumping period. The valves had been adjusted to discharge three successive times out of a cycle of 12 pumping periods. With this regulation any one plot of ground received what sewage water had been pumped for about six hours per day, and then had about 18 hours in which to dry out before it received any more water. Early in March the operating levels that control the operation of the pump were so charged that the pump should handle about 5,000 gal. at each period. This indicates that there will be about five or six pumpings per day, so that any one plot will take about half the sewage for one day, and be allowed about 2½ days to dry before the next application of sewage.

Cost of Maintenance of Rails

ANNUAL COST of maintenance of rail per mile of track for rails of 85 lb., 100 lb. and 103 lb. per yard is shown in the accompanying table, which is calculated on the basis of the following figures: cost of new rail, $41 per ton; cost of installation, including delivery and taking up and disposing of old rail, $20; salvage value of rail removed, $18 per ton; net cost in track, $43 per ton.

Column A gives the first cost of rail in terms of annual charge at 6 per cent compound interest which will yield the original cost of rail in track ($43) at the expiration of the life of the rail. Column B is the total annual charge including the figure in Column A plus interest and taxes as follows. (1) interest at 6 per cent and tax at 1 per cent on $43, or the annual interest and taxes on the value of rail in track; (2) interest and taxes at the same rates on $18, or the annual carrying charge to the railway at scrap value of rail in track. These two items are $3.01 and $1.26 respectively, or a total of $4.27.

Columns C, E and G give the total annual charges per mile of track for the three weights of rail. Columns D, F, and H are the same figures plus the annual cost of rail maintenance per mile of track, this cost being $135 for the 85-lb. rail, $114 for the 100-lb. and $86 for the 103-lb. rail, under the same conditions of traffic and track.

ANNUAL COST OF MAINTENANCE OF RAIL PER MILE OF TRACK

			85-lb. Rail 133.57 Tons per Mile		100-lb. Rail 157.14 Tons per Mile		130-lb. Rail 204.29 Tons per Mile	
Life of Rail Years	First Cost A	Annual Charge Per Ton B	Annual Charge C	Annual Maintenance D	Annual Charge E	Annual Maintenance F	Annual Charge G	Annual Maintenance H
1	$40.566	$44.836	$5,989	$6,124	$7,046	$7,160	$9,160	$9,246
2	19.629	23.899	3,192	3,327	3,755	3,869	4,882	4,968
3	12.743	17.013	2,272	2,407	2,673	2,787	3,476	3,562
4	9.255	13.525	1,807	1,942	2,125	2,239	2,763	2,849
5	7.202	11.472	1,532	1,667	1,803	1,917	2,344	2,430
10	3.077	7.347	981	1,116	1,115	1,269	1,501	1,587
15	1.743	6.013	803	938	945	1,059	1,228	1,314
20	1.102	5.372	718	853	844	958	1,097	1,183
25	0.739	5.009	669	804	787	901	1,023	1,109
30	0.513	4.783	639	774	737	866	977	1,063

This table is condensed from a tabulation accompanying a paper on "Economic Weights of Rail for Various Classes of Traffic," read at the annual meeting of the Roadmasters and Maintenance of Way Association by J. B. Baker, engineer of maintenance of way, Pennsylvania System (see *Engineering News-Record* of Oct. 7, 1920, p. 715).

Topographers Use Fire Lookout Towers

Topographic engineers of the U. S. Geological Survey, while working on triangulation in the heavily timbered area of northern Maine, saved great expense by making observations from the numerous steel lookout towers erected by the Maine Forestry Commission to aid in protecting the timber from fire. These lookout towers range in height from about 40 to 70 ft. and in each of them a watchman is stationed day and night during the summer and fall. The Government surveyors found that these towers make admirable observing stations, and by using them they were able to do work in five weeks which would otherwise have consumed four or five months. In this way they saved several thousand dollars and were able to cover a larger area than they could otherwise have covered with the funds available.

What the Government is Doing To Help Port Layout

Details of Information So Far Collected by Shipping Board and War Department and Prospects for Future

BY VIRTUE of the recent Shipping Act the United States Shipping Board and the Secretary of War are jointly loaded with the responsibility of promoting port development and the transportation facilities in connection therewith. The extent to which this instruction has been carried out was well outlined by Capt. F. T. Chambers, C. E. C., U. S. N., at the recent meeting of the American Association of Port Authorities. Capt. Chambers was chief engineer of the Port Facilities Commission on the Shipping Board and is now working with the Chief of Engineers of the Army in port work. He is therefore particularly well qualified to speak on the subject.

He said in part:

As the Shipping Board is required by law to sell the ships built during the war it is plain that it cannot be expected to go extensively into the provision of port facilities by the expenditure of government funds. It did find it very necessary before it could build ships to erect shipyard plants in which to build them. But this was war emergency. It furthermore found itself in an insecure position with regard to dry-dock business during the war, first with the Division of Shipyard Plants of the Emergency Fleet Corporation, and afterward as chief engineer of the Port Facilities Commission of the Shipping Board. It was our endeavor to place the necessary dry-docking facilities in "going" ship repair yards so they would be available in peace times as well as for the war emergency. As time was the chief consideration we adopted timber constructed floating dry-docks and marine railways as our program. The marine railways were designed primarily for the wooden ships, and a haul-out capacity of 2,500 tons was adopted for the earliest, changed afterward to 3,200 tons for later designs. The floating dry-docks ranged in capacity from 5,000 to 20,000 tons lift. They were intended for more general use than the marine railway and their capacities were determined in each case, first by the apparent requirement of the particular harbor in question, but also to some extent by the commercial concern which was to own and operate the dock. We then placed dry-docks, or marine railways, or both, in many harbors inclusive of Portland, Maine; Boston, Somerset, Providence, New York, Philadelphia, Baltimore, Norfolk, Charleston, Savannah, Jacksonville, Tampa, Pensacola, Mobile, New Orleans, Beaumont, Galveston, Los Angeles and San Francisco. We also advised the authorities at Portland, Ore., with reference to the design of the new floating dry-dock for that port, and by general agitation of the subject we believe we have been instrumental in starting other dry-dock projects in various ports, so that, except for extremely large ships, the situation as to dry-docking and repairs has been fairly well covered.

The Port Facilities Commission also did some work to relieve the coaling and bunkering situation. Among other items we equipped ten barges with mechanical elevators for bunkering ships in the stream or alongside commercial piers, thus relieving commercial coal piers for the larger operation of supplying cargo coal.

As time went on we were able to devote attention to terminal design, and while we were not justified in spending Shipping Board money for the construction of such facilities, we made many commmercial studies and general engineering layouts, and advised local authorities both as to prospects of business and upon terminal design. We did not hesitate to say to some authorities that their local prospects did not promise hope of a successful overseas business. For instance, at one New England port we stated that the situation of the city with reference to the railroads would not justify the construction of wharfage for foreign trade. At a Southern city we advised a detailed study of the hinterland by the local board of trade before constructing an addition to the municipal terminal, rather than building a pier on the chance that it would bring business to the city. We also made studies of river terminals for large variations of water level under flood and drouth conditions. We started a collection of statistics upon foreign ports but, upon the close of the war and the curtailment of personnel in general, found ourselves under a new administration which did not consider expenditures for the collection of trade statistics for the promotion of port facilities justified. When about to lose practically the entire port facilities force, the Board of Engineers for Rivers and Harbors offered to take over all that part of the personnel engaged upon United States port work. I transferred with this force, taking with me the valuable port facilities files, so that the work is now continuing.

We are still advising local port authorities and to do so we must necessarily have the facts, not only as to local port facilities but as to prospective and actual trade, upon which alone good design can be based. It is a remarkable fact that many boards of trade and chambers of commerce have little thought of investigation along the lines of character and quantity, origin and destination of cargo. If any one of the individuals were contemplating the expenditure of his own funds upon a new merchandising business, he would, beyond a doubt, make very sure of the source of his supplies and the market for them, but the same mode of procedure does not seem to apply when a municipal trade body contemplates an overseas business for its port. I was asked recently by the Mayor of a large river city to tell him off-hand the cost of a terminal for his river front. He quite lost patience with me when I insisted upon a quantitative analysis of the cargo he hoped to handle. Nor did he authorize the officials under him to make the necessary study. Much of an educational nature is necessary to be done if we are to encourage the construction of efficient terminals.

Cities Must Share Port Cost

No port should be given Government aid as to channels and anchorage ground until it can convince the Chief of Engineers that it will do its share with regard to terminals. States with only one first class harbor should be brought to look upon that harbor as the property of the state to be properly developed along modern scientific lines. For we may here assert that only the very largest cities can possibly afford the necessary expenditures for a properly coordinated terminal. Then, too, the waterfront of our principal harbors where no state or municipal control exists is being more and more occupied by industrial plants, in most cases requiring little or no actual berthing space for ships.

We think that in the central nucleus collected in Washington, under the Board of Engineers for Rivers and Harbors, and in the field offices of the division and district engineers at our ports and river terminals, we have the means at hand for the proper investigation and for sound, well based advice to ports. But we do not expect to depend upon this organization alone. In the other departments of the Government we have important sources of information in the Shipping Board, the Bureau of Customs, the Bureau of Foreign and Domestic Commerce, the Interstate Commerce Commission, the Office of Naval Intelligence, etc. Without utilizing them to their fullest extent we would not only lose available data, but would invite duplication of effort, with consequent lack of economy and the loss of temper on the part of those commercial concerns otherwise called upon more than once for the same information by the various Government agencies.

We propose, therefore, to form an advisory commission or board, composed of representatives of the interested departments, to meet from time to time as required to co-ordinate the statistical effort and discuss new points. It is

anticipated that such procedure will prove most economical. For instance, too much attention has in the past been devoted to values in dollars at the expense of losing sight of quantities and tonnage. Doubtless many of you have tried to find in commercial statistics the increase or decrease in shipments for the past fiscal year. You have always found a statement in money but, except for a few special commodities, such as coal, ore and grain, the quantity or weight is missing. Exports and imports are, at present, usually given by customs districts. They would be much more valuable by ports. Changes of method, often slight, will increase the usefulness of the data collected, without large additional expense.

Statistics Needed

We propose to gather together both the trade statistics upon which all port business should properly base, and which is so necessary to economic port design, and the port statistics of all classes to show the shipmaster what he may expect at each individual port, and the port authority what is the present status of the port, in order that future improvements may follow a well preconceived plan which will keep pace with the growth of business in the most modern and efficient way. By studying the data upon the advanced port, the backward port will learn its own need.

We have prepared a comprehensive questionnaire, with elaborate supporting tables, which we will shortly send to all our districts. This, when completed, will show, for each port and upon the same basis, all that goes to make its port facilities, or which is useful in the design of such facilities. From time to time, as the information is completed, separate pamphlets will be published. Port facilities data for each large port will be contained in a single publication. Small ports in district groups will be treated separately, but in one pamphlet.

About a year ago the Port Facilities Commission of the Shipping Board published a pamphlet entitled "Twenty-seven Ports of the United States." The information contained was not so comprehensive as that now proposed, but the demand for copies was such that the edition was soon exhausted. The new publication will have a port facilities map for each port, showing by symbol the exact location of each facility, such as overseas piers, coastwise piers, cargo coal, coal and oil bunkers, shipyards, dry docks, etc. There should be a great demand for these pamphlets. With their help and with the commercial statistics grouped in a separate volume, the producer should be able to select the economic port, the port merchant may determine the location of available cargo and the placement of imports, the shipper can judge whether it is best to ship by rail or by inland waterway. If carried to the extent proposed, a basis will be had for separate and combined rail and barge rates. Full knowledge of the facts will enable the Chief of Engineers to base his recommendations for channel and harbor improvements upon the real merits of each individual case. Above all, the very best information will be in available form for advice to ports.

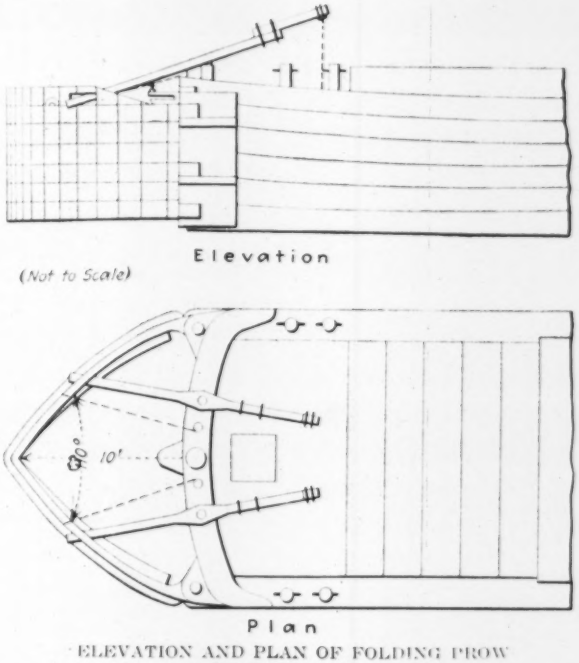
In designing port facilities there has been too little consideration given to the business to be handled. Many individuals in promising ports are anxious to see the home town acquire a shipping business, but they have, in most instances, little idea how to start. From our experience, much education is necessary and this we hope to supply. We have, in fact, had considerable experience in this work already, and in this connection I desire to say here that in our advice to ports we have not in the past, and do not in the future expect to lose sight of the fact that there is a limit to our mission, beyond which we should not go. The information which we collect and the advice which we give is just as available to you as it is to state or city authorities. We naturally do some designing in detail for the Government, but we set a limit with port authorities, advising them that they must employ their own engineers for the details of design and construction. I hope that we may be of assistance to you, and that in turn you will all spread the news that the Chief of Engineers and Board of Engineers for Rivers and Harbors form an agency in co-ordination with the United States Shipping Board for Government co-operation in port development.

French Devise Adjustable Prow to Increase Speed of Barges

Resistance Lowered Twenty-Three Per Cent in Tests Made With Folding Panels That Sharpen Barge's Flat Bow

BECAUSE of the immense impetus given to traffic upon the Seine River during the war and because of the possibilities present of materially increasing that traffic, various methods have recently been tried for increasing the speed and decreasing the resistance to navigation of the many types of barges and canal boats operating on the Seine. Among such means is a device proposed by M. Brisset, described in a recent issue of *Annales des Ponts et Chaussées*, and with which recent experiments have been made, resulting in the lowering of resistance to navigation of barges of 23.5 per cent.

The device designed by M. Brisset consists mainly of two of slightly curvilinear movable wings, each one of



ELEVATION AND PLAN OF FOLDING PROW FIXED TO BARGE

which is supported by three hinges fixed at the extremities and in advance of the vertical walls of the barge. When in use these two wings, extended, just come together, designing a simple form of prow. When docked or in passing through locks the wings are released and spread back against the prow of the barge. When in the latter position the length of the barge is increased only by a very small quantity—in the neighborhood of 1½ ft. when the wings are made entirely of wood. This length, it appears, can be shortened to an excess length of 0.3 of a meter, or approximately 1 ft., in case correctly designed metal wings can be secured. When extended the apex of the angle formed

by the two wings is 10 ft. in advance of the tangent to the prow of the barge and its center line, and the interior angle of the two wings at the point of joining is approximately 110 deg.

Manipulation of Wings

Various systems were devised by which to manipulate the wings. One method is illustrated in the accompanying sketch. Two levers, pivoted and inclined, permit the wings to be moved much in the same manner as the rudder of a boat, at the same time furnishing supports to the upper cross-beams of the wings. This arrangement is considered the most practical.

The important point in the investigation was to determine if it were possible to lower the resistance to navigation of the barge, in spite of the fact that this cut-water had no bottom, permitting eddies to be formed between the wings. In order to clear up these points a series of trials was held. Trials were first made with an ordinary barge completely loaded, then upon the same barge towed exactly along the same course after having been furnished with the device mentioned above. The course picked out for the trials was approximately rectilinear in shape and situated in a section of the Seine River where the currents are regular and where the channel is large enough to permit the passage of other river traffic without alterations in the course of the trial boat.

In order to secure best results several precautions were taken. Only a certain number of selected trips, out of many trial trips made, were used as a basis for computation of resistances, and a mean of these was taken. Two sets of tests each were made with the speed of the engine in the propelling tug geared at 150, 170, and 200 r.p.m. The number of revolutions were recorded at two-minute intervals by tachymeters, and in addition the total number of revolutions were also recorded by another speed-recording machine. For the trips finally selected as test trips there was never a greater variation than two revolutions from the maximum and minimum, and never more than one revolution from the mean.

The mean speed was developed from the following formula, after a series of tests had been made in which V_1, V_2, and V_3 represented speeds in one direction (with or against the current) and V_2 and V_4 speeds in the opposite direction:

$$V = \frac{1}{2}\left[\frac{V_1 + 2V_2 + V_3}{4} + \frac{V_3 2V_4 V_5}{4}\right]$$

Tractive effort was measured by means of an hydraulic dynamometer and a speed recorder of the Richard type. Though the curve plotted by the dynamometer was of such a small scale that it could not be used as an absolute check against the two-minute interval speed recordings, nevertheless the curve checked up any irregularities which the other system failed to reveal. Because of the dynamometer a number of tests that might have been used were discarded.

For half of the tests the barge was attached to a tug by a towline 120 m., or 393.6 ft., long, and in the other half by a line 80 m., or 262.4 ft., long. The variance in length of towline was to determine if navigation was impeded by the presence of the barge close to the backwater from the tug propeller. The tug used in the tests was of 366.3 tons displacement and drew 7 ft. of water.

According to an established formula, based upon use of tugs of 100 tons displacement and of standard design, the resistance offered by the type of barge with which tests were made would be expressed by the formula:

$$(1) \qquad R = 78V^{2.25}$$

where R is the resistance and V velocity in meters per second. The accompanying table shows that the discrepancy between measured and calculated resistance, with the barge not using the false prow, is approximately 16 per cent. The regularity of the occurence of this percentage led to a revision of the formula, which for a 120-m. towline would be:

$$(2) \qquad R = 67V^{2.25}$$

Resistances observed for the tests made with a towline of 80 m. were also lower than calculated resistances. It was therefore proven that the resistance was greater with an 80-m. towline, and revision of the general formula was made to apply in the instance when an 80-m. towline was used. This revised formula is

$$(3) \qquad R = 69V^{2.25}$$

The second series of tests in which the prow was used showed that the calculated resistances were nearest the measured resistances when the formula

$$(5) \qquad R = 52V^{2.25}$$

was used. Comparing this equation with (2) an economy of effort of 23.5 per cent is noted.

The use of these wings, which do not add any appreciable weight to the boat nor encumber it in any way, and which have adaptation for use upon canal boats, will, it is stated, considerably reduce towage costs. It will also allow more prompt transportation of materials and lead to a consequent increase in amount of tonnage handled.

TABLE I. MEASURED AND CALCULATED RESISTANCES

	Speeds		Resistance in Kilograms to 100 Tons Displacement		
	Meters per Second	Kilometers per Hour	Test Measurements	Formula Computations	Per Cent of Error Between Measured and Calculated Results
Tests with Tow Line of 120 meters	1.67	6.012	214	247	15
	1.87	6.732	274	319	16
	2.14	7.704	373	432	16
Tests with Tow Line of 80 meters	1.64	5.904	213	237	11
	1.84	6.624	264	307	16
	2.13	7.668	380	427	12

The tests were made under the direction of Major of Engineers Dugardin, engineer of roads and bridges, temporarily attached to the military exploitation of navigation upon the Seine River.

Power Commission Issues Rules

Under date of Sept. 3, 1920, the Federal Power Commission issued its rules and regulations under which applications for licenses to use Federal water power must be made. These rules lay down all of the forms which must be followed in dealing with the office of the commission, which is in Washington, D. C. Copies of the rules may be obtained by writing to the Federal Power Commission, O. C. Merrill, Executive Secretary, Washington, D. C.

Comparisons of Modern Steam and Electric Locomotives

Extracts from the three principal papers presented before the joint meeting of the Metropolitan Section of the American Society of Mechanical Engineers, the Railroad Section of the American Society of Mechanical Engineers, and the New York Section of the American Institute of Electrical Engineers, held at New York, Oct. 22, 1920.

The Steam Locomotive

By John E. Muhlfeld
Railway & Industrial Engineers, Inc., New York

To reflect initial and operating costs from a credit or an investment standpoint and to interpret faithfully on the basis of expert judgment, backed by practical experience, the probable effect on the annual balance sheet, any investigation for the purpose of determining upon the advisability of electrical or steam operation for an existing or new line of railway should be made, preferably by a committee consisting of experts in railway, mechanical, electrical, and civil engineering, transportation, and accounting, without any endeavor to modify the best steam railroading methods to suit the requirements of electric traction, and by keeping clearly in mind the fundamental fact that where anything within reason is possible, provided enough money can be spent, if the auditors' annual statement cannot show the balance on the right side of the ledger, the project will have failed from the most important point of view.

Comparisons have been made between the operation of new, up-to-date electric and of obsolete steam installations, and assumptions have been made of extraordinary steam locomotive standby fuel losses. It is just as misleading to compare the most efficient electric locomotive operation on the St. Paul with that of its saturated steam locomotives of 1910 as it would be to compare the most efficient superheated steam locomotive performance on the Baltimore & Ohio with that of its electric locomotives.

Several years ago a report was made on the advisability of electrifying about 275 miles, or a division, of one of the more prominent western lines. When all involved factors were properly adjusted the net capital expenditure of $4,000,000 required for electrification compared with $1,000,000 as needed for modernizing the steam equipment, and the estimated annual operating saving of approximately $750,000 from electrification was wiped out and replaced by a saving of $250,000 from a continuation of the improved steam operation.

When engineers and politicians propose reckless superpower plans for the electrifying even of such belts of steam roads as lie in the densely populated district between Washington, D. C., and Boston, at a new capital cost aproximating a billion of dollars, and in addition mark off the books the principal value of existing steam locomotives, passenger cars, shops, and terminal and intermediate facilities that would be unsuitable for electrified service, they are planning either a new road to railroad bankruptcy, or a further burden in traveling and shipping cost, or in taxes.

Before the electric locomotive can be made permissible for general application the electrical engineer must reduce first costs; promote interchangeability; provide a motor which will efficiently, economically and flexibly cover a wide range of speeds and loadings, and substantially reduce current losses. Likewise the steam railway mechanical engineers must become more active in modernization and bring about improvements that will substantially increase the capacity and thermal efficiency of the steam locomotive by the use of higher steam pressures and superheat.

Electrification increases the capacity of a terminal, but an analysis of the situation of the New York Central shows that this is not due to decreasing locomotive requirements through the use of multiple units as is usually stated. . . . In the handling of heavy tonnage trains by the unlimited combining of electric locomotive units, the factors of peak load, transmission lines, and power plant capacity must all be considered with the probability that permissible modern steam locomotive train units can be more economically handled over dense traffic lines than the electric multiple unit super-trains. The tonnage to be handled without rear end or intermediate helpers is limited by the ability of the draft rigging on the cars to withstand the pull and shock, and this limitation can be readily met and exceeded in steam locomotive design and operation, as may be noted from the following comparison of the St. Paul electric freight and the Virginian steam freight articulated types of locomotives:

	St. Paul Electric Articulated, Lb.	Virginian Steam Articulated, Lb.
Tractive power, in simple gear, maximum	132,500	176,600
Tractive power, in compound gear, maximum		147,200
Tractive power, at 15 miles per hour	71,000	108,000
Total weight on driving wheels	448,000	617,000
Total weight of locomotive	564,000	832,000
Factor of adhesion—maximum tractive effort	3.38	3.49

The average freight car is in main line movement only about 10 per cent of its life. Therefore, increasing train speeds beyond established economic limits at the sacrifice of tonnage, with an increase in fuel, track and equipment upkeep and danger of operation is not the solution of the freight traffic problem. The electric locomotive is a constant speed proposition. The steam locomotive can be more efficiently operated over the continually changing up and down grades and curves.

Fuel Consumption

Great economy in fuel consumption and cost is the principal claim for electrification. Recent tests of a hand-fired locomotive on the Santa Fe show an average coal consumption for gross 1,000-ton miles of 114.8 lb. From the foregoing it can be assumed that the average yearly performance will approximate 100 lb. of 12,000 B.t.u. coal per 1,000 gross ton-miles, or equivalent to what we are promised for the expenditure of billions of dollars of new capital and the loss of billions of dollars worth of investment in existing plant and equipment to inaugurate the comforts of electrification.

The offsetting fuel and energy losses, due to standby in steam operation, and decrease in efficiency on account of fluctuating loads in the electrical operation must not be lost sight of, as well as those incident to the transforming, transmission and conversion of electric current. It is unquestionably true that when operating under ideal fixed load conditions, the central power station, either hydro-electric or steam, can produce a horsepower with less initial energy input than is possible on a steam locomotive. It is also true that the standby losses on existing steam locomotives are, in ordinary practice, a serious proportion of the total fuel consumption, but it is likewise a fact that the majority of these can be substantially reduced if not entirely overcome by modernizing the present equipment and improving maintenance and operation which would then rob the advocates of electrification of their main arguments.

Thermal Efficiency

Furthermore, the production of electric current involves expensive lines, plants and equipment, as well as tremendous losses from the generator at central power stations to the bus bar on the direct-current side of the transformer where the current is usually metered for billing. Also the secondary system (rail bonding and feeder lines) is responsible for further losses in current, all of which, after allowing say 10 per cent regeneration not only limit the capacity of the electric zone but also materially increase the arbitrary

electric costs usually considered, so that it is safe to say that the actual dead loss in power from the central power station to the electric locomotive drawbar will be not less than 50 per cent.

Comparing the electric and steam locomotive figures, the relative percentage of power delivered at the track rails to 100 per cent B.t.u. in the coal would be:

Kind of Locomotive	Net Thermal Efficiency at Load Ratings of 100 Per Cent	75 Per Cent	50 Per Cent
Electric	5.79	5.95	4.54
Steam, superheated	3.85	4.83	5.88
Steam, saturated	2.70	3.86	4.47

As 100 per cent load rating conditions would, in practice, occur only momentarily and as the majority of the drawbar load represents from 30 to 60 per cent of the locomotive maximum drawbar capacity, comparison should properly be made only of the net thermal efficiencies at 50 per cent load ratings. At speeds of from 15 to 75 miles per hour the existing superheated steam locomotive thermal efficiency actually ranges from 5.3 to 8.1 per cent as compared with the calculated figures of from 4.83 and 5.88 per cent for 75 and 50 per cent load ratings, respectively. Adding to this an increase of from 15 to 50 per cent in net thermal efficiency that may be produced from developments now under way and the steam locomotive of the future will be quite a respectable assembly of engineering efficiency.

Maintenance and Repair Costs

In determining the maintenance cost of the electric locomotive the popular error is to take into account the locomotive proper, where as true comparison can only be made by including all corresponding elements as found in the self-contained steam locomotive which goes back to the upkeep of all facilities having to do with the utilization of the fuel or water power, including the central power station buildings and transmission line equipment. Until a true reflection of the upkeep cost per electric locomotive, or per 1,000 gross ton miles hauled, can be given by including all the facts and elements of age and mechanism embodied in the steam locomotive, comparisons will all be worthless.

In order to meet the ideal conditions for electrification, the traffic should be uniformly spread or scattered over the 24-hr. period. With the steam locomotive the traffic requirements are met by the distribution and utilization of the necessary number of self-contained motive power units as required, regardless of the capacity of one or more central power stations or of any limitation in quantity, or in price, of the total available power output.

Since the development of regenerative braking with the electric locomotive, great emphasis has been laid on increased security of operation by holding the trains and motors temporarily converted into generators to produce electricity returned to the line for use by some other locomotive in pulling a train. When the power so generated cannot be directly used by another pulling locomotive on the line, it must be otherwise absorbed, and it remains for the electrical engineers to prove just how much of it is lost in conversion or by absorption.

In steam locomotive practice there are factors of radiation and freezing to be reckoned with, which gives the electric locomotive the advantage in winter, but this is largely overbalanced during the summer when the main motors heat, and require cooling at terminals.

While the electric locomotive has the advantage of not being required to take on fuel and water, delays in steam locomotive practice in taking water have been entirely eliminated through the use of track troughs, and with modern fueling facilities either coal or oil can be quickly supplied, where necessary, between terminals.

While there is much existing steam road trackage that can and should receive first consideration as regards electrification for the purpose of eliminating gases from underground terminals and tunnels, to give relief to terminals or line traffic congestion by combined rapidity and frequency of train movements in the vicinity of large commercial and industrial centers, or where transportation and operation are auxiliary to mining or other industries requiring the extensive use of electricity, it would be financial suicide to electrify immediately adjacent connecting and intermediate longhaul mileage, particularly in view of the improvements that can be made in both existing and new steam locomotives in the matter of reducing smoke, sparks, cinders and noise, and in increasing general capacity, efficiency and economy in operation and maintenance.

The Electric Locomotive

By F. H. Shepard
Director of Heavy Traction,
Westinghouse Electric & Manufacturing Co.

THE LIMIT to physical expansion of railroad line and of terminals has been just about reached in many cases, on account of both the prohibitive cost and the inefficiency of terminals of unworkable size. A large measure of relief can still be secured by line and terminal revisions and improvements; but when the inevitable increase in the demand for traffic movement of the future is considered, these improvements savor, more or less, of expedients to secure relief which can only be temporary and very limited in degree. The solution lies, to a large extent, in railroad electrification.

With the present standards of train make-up, classification and terminal handling, electrification will double the capacity of any railroad. With the better equipment we can expect in the future, together with the evolution of improved methods of operation contingent on electric power, this capacity should be doubled again, thus securing four times the present capacity. Two conspicuous cases of this have been the Norfolk & Western and the Chicago, Milwaukee & St. Paul. In the case of the Norfolk & Western, two electrics handle the same train as was formerly handled by three Mallet engines, but at twice the speed.

Flexibility in Design and Operation

The advantage of electric power is its great flexibility and mobility. The difference between locomotives, steam and electric, is fundamental. The steam locomotive carries its own power plant, while the electric locomotive, on the other hand, is simply a transformer of power. The design of the steam locomotive is circumscribed utterly by the necessity of tying up the rest of the machine to a steam boiler. On the other hand, the electric locomotive assembly can differ amazingly as to type, length, axle loading and driving connections. A group of small motors does not differ materially from a single large motor in efficiency. The speed and power, therefore, of an electric locomotive is limited only by conditions of track and construction and condition of car equipment. It thus becomes entirely practicable to build an electric locomotive to take any train which will hold together, over any profile whatever, and at any desired speed. Therefore, it should easily be practical to very greatly increase the speed of our freight trains so that they could all run at a common speed not very different from that at which the superior trains are operated.

Without the limitation in train speed commonly accepted as a handicap to operation of tonnage trains, who can say what the limit to train load will be with electric power? Our present methods have been built up entirely under the necessities and limitations of the steam locomotive. This is evidenced by the existence of intermediate terminals at the ends of all the so-called engine districts, where all traffic halts. Again, the steam locomotive requires attention en route, needs supplies of water and coal, and, because of its slow movement when hauling our present tonnage trains, it is frequently sidetracked for superior trains, and thus there are more and still more halts to traffic.

Coming now to the comparative performance of steam and electric locomotives, it is important to bear in mind their fundamental difference to the one, a generator of power, and the other a transformer of power. The generation of power in central stations is surrounded with many refinements, and in the consumption of coal, there is every opportunity for skillful handling and supervision, so

that the thermal efficiency of a modern central station is relatively high and is also continuously maintained. With the steam locomotive, on the other hand, the thermal efficiency is dependent not alone upon the design of the locomotive, but the manner in which it is worked, its condition, which differs widely from the best, and finally by the skill in firing. The electric locomotive, on the other hand, consumes power only when in service, and works at any load at its designed efficiency. The average performance, in the case of the electric, approximates the maximum in efficiency, while the steam, on average performance, will differ widely therefrom.

There are a considerable number of different designs of electric locomotives all in successful operation, and each possessing certain advantageous features. Further experience will, undoubtedly, result in the survival of common types for the different classes of service. The great latitude with which electric locomotives can be designed, while fundamentally most desirable, is in itself at the present time, somewhat of a handicap. This is now the subject of intensive analysis and this study is undoubtedly developing as well, a better knowledge of the running characteristics of the steam locomotive.

The Electric Locomotive

By A. H. Armstrong

Chairman Electrification Committee, General Electric Co.

OWING TO handicap of precedent and prejudice, electricity must take up the railway problem where steam leaves off. In other words the proof is up to the electrical engineer proposing any marked departure from commonly accepted standards as established by long years of steam engine railroading. Thus while a maximum standing load of 60,000 lb. per axle has been generally accepted for steam engines, it is well known that an impact of at least 30 per cent in excess of this figure is delivered to rail and bridges due to unbalanced forces at speed. However, owing to the flexibility of electric locomotive design, there is no immediate need of exceeding steam practice in this respect, although this and other reserves may be called upon in the future.

Accepting the Mikado and Mallet as the highest developments of steam road and helper engines for freight service, the following general comparison is drawn with an electric locomotive that it is entirely practicable to build without in any respect going beyond the experience embodied in locomotives now operating successfully.

COMPARISON STEAM AND ELECTRIC LOCOMOTIVES

	Mikado	Mallet	Electric
Type	2-8-2	2-8-8-2	6-8-8-6
Wt. per driving axle	60,000 lb.	60,000 lb.	60,000 lb.
Total wt. on drivers	240,000 lb.	480,000 lb.	720,000 lb.
Total wt. loco. and tender	480,000 lb.	800,000 lb.	780,000 lb.
Trac. eff. at 18% coef	43,200 lb.	86,400 lb.	129,600 lb.
Speed on 2% grade	14 m.p.h.	9 m.p.h.	16 m.p.h.

The above analysis brings out the fact that to equal the hourly ton mile performance of one electric locomotive it would require three and four engine crews respectively for the Mallet and Mikado types.

The electric locomotive has demonstrated its very great advantages in relieving congestion on single track mountain grade divisions. In view of the facts, it is a modest claim to make, therefore, that the daily tonnage capacity of single track mountain grade divisions will be increased fully 50 per cent over possible steam engine performance by the adoption of the electric locomotive.

Regenerative Braking

Not only are air brakes entirely relieved and held in reserve by electric regenerative braking but the potential energy in the descending train is actually converted into electricity which is transmitted through the trolley to the aid of the nearest train demanding power. Aside from the power returned from this source (14% of the total on the Chicago, Milwaukee and St. Paul Railway) the chief advantage of electric braking lies in its assurance of greater safety and higher speeds permitted on down grades.

Probably in no one respect does the electric locomotive show greater advantage over the steam engine than in cost of maintenance. Special importance attaches to this item of expense in these days of high labor and material costs. In order to draw a fair comparison, however, there should be added to back shop repairs, all expenses of round house, turn table, ash pit, coal and water stations, in fact the many items contributing to rendering necessary steam engine service, as most of these charges are eliminated by the adoption of the electric locomotive. Including all engine service charges, the facts available give foundation for the claim that electric locomotives of the largest type can be maintained for 25% to 30% of the upkeep cost of steam engines operating in similar service.

To afford a common basis for comparison a single assumption seems permissible and a rate of 2½ lb. of coal per kilowatt-hour is taken as representative of fair electric power station practice. While the electric locomotive demands power only when in motion, the steam engine requires coal at all times during the twenty-four hours, whether doing useful work, standing idle or coasting down grade. In tests made on the C. M. & St. P. Ry. the run of a more modern steam engine would have effected a material reduction in the 23,640 lb. of coal burned in doing useful work, but the amount of coal wasted in standby losses (9,042 lb.) might have been duplicated or even possibly increased with larger grate area. As standby losses constitute so large a proportion of the total coal burned (27½% in this instance) it is apparent that enormous economies over the simple engine tested must be realized in the modern superheater and other improvement since introduced to offset in part the high inherent efficiency of the electric locomotive.

Except over very long runs with terminals at the same elevation it seems hardly possible therefore accurately to compare engine performance over different profiles by such a variable unit as pounds coal per 1,000 ton-miles.

A truer understanding of what takes place under the engine boiler may be shown by continuous records of coal burned, tons moved, profile, delays, etc., all reduced to pounds of coal burned per useful horsepower-hour work done at the driver rims with segregation of the many standby losses.

ANALYSIS STEAM AND ELECTRIC RUNS
HARLOWTON—THREE FORKS

(Per 1,000 Tons Moved)

	Steam	Electric
Kw.-hrs. at driver rims	2,038	2,038
Hp.-hrs. at driver rims	2,625	2,625
Coal per hp.-hr. driver rims	9.02 lb.	*3.09 lb.
Credit regenerative braking		0.55 lb.
Standby losses 27½ per cent	2.47 lb.	
Total coal per rim hp.-hr	11.49 lb.	2.54 lb.

* Measured at power house and includes locomotive losses and 12 per cent transmission and conversion loss.

Under the same conditions a modern engine would undoubtedly have consumed much less than 9.02 lb. coal (11,793 B.t.u.'s) while doing work measured at the driver rim. The addition of superheaters gives greater output and economy while mechanical stokers add output only and, it is claimed, at some expense in economy over good hand firing. However efficient the power plant on wheels may reasonably be developed without too seriously interfering with the sole purpose of the steam engine, the hauling of trains, it can never approach the fuel economies of modern turbine generating stations. Whatever transmission and conversion losses are interposed between power house and electric locomotive are more than compensated for by the improvement in the load factor resulting from averaging the very fluctuating demands of many individual locomotives.

Each individual electric locomotive will reproduce almost exactly the record of all others in similar service, little

influenced by either extreme cold or skill of the engineer, while the fireman so called and still retained, has nothing to do with the matter at all. There is no creeping paralysis gradually impairing the efficiency of an electric locomotive until temporary relief is obtained through frequent washing of boiler and round house tinkering inevitably ending up in the major operations annually performed in the back shop hospital on the steam engine to keep it going. It is for such reasons that the electrical engineer is slow to accept general statements of average service operation based on the results of tests usually made on steam engines in excellent condition and skillfully handled.

It is with some knowledge of all these facts that the broad statement is made that the general adoption of the electric locomotive would probably result in saving fully two-thirds the fuel now burned on present steam engines and possibly one-half the amount of fuel necessary to steam engines of the most modern construction.

Comparative Cost

The superior operating advantages of the electric locomotive are admitted by many who believe the first cost to be prohibitive, largely due to the trolley construction, copper feeders, substations, transmission lines, etc., necessary to complete the electrification picture. The steam engine also demands a formidable array of facilities peculiar to itself. Proper facilities for rendering adequate steam engine service apparently adds some 62% to the cost of the latter and no cry of extravagance has ever been raised in this respect.

One advantage of the electric locomotive rests in the longer engine divisions which they make possible. Two of the four steam engine divisions comprised in 440 miles of the St. Paul were wiped out by electrification and certain sidings and yard tracks were dismantled. To the above exclusively steam engine facilities should be added therefore the expense of engine division points not necessary to successful electric railroading.

Summary

Some of the principle advantages claimed for the electric as compared to the steam locomotive may be briefly stated as follows:

1.—No structural limits restricting tractive effort and speed of electric locomotive than can be handled by one operator.
2.—Practical elimination of ruling grades by reason of the enormously powerful electric locomotives available.
3.—Reduction of down grade dangers by using regenerative electric braking.
4.—Very large reduction in cost of locomotive maintenance.
5.—Very large saving of fuel, estimated as two thirds the total now burned on steam engines in operation.
6.—Conservation of our natural resources by utilizing water power where available.
7.—Material reduction in engine and train crew expense by reason of higher speeds and greater hauling capacity.
8.—Increased valuation of terminal real estate following electrification.
9.—Increased reliability of operation.
10.—Material reduction in operating expense due to elimination of steam engine tenders and most of the Company coal movement, the two together expressed in ton miles approximating nearly 20% of present gross revenue ton mileage.
11.—Large reduction in effect of climatic conditions upon train operation.
12.—Postponement of immediate necessity for constructing additional tracks on congested divisions.
13.—Attractive return on cost of electrification by reason of direct and indirect operating savings effected.
14.—Far reaching improvements in operation that may revolutionize present methods of steam railroading.

New York's Freight Handling Problem

Extracts from a paper by Col. Charles D. Hine, special agent Erie R.R., at New York, presented before New York Section Am. Soc. C. E., Oct. 20, 1920.

NEARLY fifty terminal plans of more than fifty years since the Civil War have in the Metropolitan District of New York remained in the project stage. Plans and special public commissions are always necessary and sometimes valuable, but plans and special commissions move no freight. The distribution of freight and food products after arrival in the Metropolitan District, it is common knowledge, is crude, unscientific, expensive and wasteful. No satisfactory formula has yet been devised to measure the cost to the carriers and to the public of terminal congestion.

Need for Expansion of Storage Facilities

Distribution in the Metropolitan District is directly concerned with three elements of transportation. First, a relatively long haul or large unit consignments moving by rail or water; second, delivery to or from warehouse, consignee, or connecting carrier by lighter, truck, dray or cart; third, warehousing for incoming or outgoing freight awaiting delivery or shipment. The last named, storage, is the underfed, stunted little brother of the transportation family. Long haul today by rail and water is comparatively easy. The real problem is a terminal one. In many cases it is almost a physical impossibility to enlarge internal freight yards or steamship piers. Relief must come through such terminal handling as will permit quicker movement of equipment. The greatest possibilities lie in expediting the short haul in small workable units, and in prodigious expansion of storage facilities.

Such expansion must take the form of segregated groups of warehouses and market warehouses at numerous suitable points in cities. The temptation to make these groups few in number and unwieldy in size must be resisted. Otherwise the congestion of trucks or lighters will, without attainable reduction, be merely transferred from rail head and pier to warehouse and market. Demountable motor bodies now in successful use in Cincinnati and other proposed devices make it feasible for long haul carriers to have numerous off-line freight station warehouses entirely disconnected except by streets from existing terminal property.

Goods reaching the Metropolitan District must be forthwith moved as far as possible in the direction of ultimate destination. This means numerous market warehouses rather than a few.

The large outlays of capital required for some of the comprehensive plans for local distribution thus far developed must probably wait until financiers and public authorities are convinced that maximum co-ordination of existing facilities has been attained. Much can be accomplished by public authority. For example: The mayors and borough presidents of the Metropolitan District could with the carriers and commercial bodies work out methods by which back haul and street congestion would be minimized. For example: Freight for upper Manhattan comes to lower Manhattan when perhaps it could better be distributed from the Bronx. Freight to and from Newark passes through Manhattan only to add to intolerable congestion.

The question will fail of comprehensive solution until it becomes political in the sense of economics and statesmanship, not in the narrow range of partisanship.

Railroad Water Consumption

The Southern Railway uses, by careful investigation of each station, 45,500,000 gallons of water per day of 24 hours, at a cost of over $1,660,000 per year. This consumption is furnished by 350 pumping plants, 60 gravity stations and 121 city supply stations, making a total of 531 water stations. It has been conservatively estimated that the average railroad wastes 15 per cent of the total amount of water used, that is, 15 per cent more water is used than is actually needed to meet requirements.—A. B. Pierce, engineer water supply, Southern Railway, in *Southern News Bulletin.*

LETTERS TO THE EDITOR

Bureau of Public Roads Will Measure Highway Bridge Impact

Sir—The matter of impact on bridges, discussed in your editorial, "A Field for Experiment," of Sept. 1920, is one which our bridge division has to consider almost daily in connection with the design of highway bridges in the construction of Federal Aid roads. Unfortunately, there is a lack of adequate knowledge on this subject. We have been at work for the past year on a series of impact tests to determine the impact effect of heavy trucks on road surfaces, and our tests indicate that the effect of impact on our highways is very considerable.

It is true that we know little of the stress developed either in the bridge floor on in the bridge members due to impact. Our records as of Jan. 17, 1920, show that 24 states use an impact allowance of variable amounts. Fifteen use no impact allowance, leaving nine states for which we have no records available I am inclined to believe that a study of impact on highway bridges is important from the standpoint that it will lead to more rational design, but from the standpoint of the relative expenditures on roads and bridges we have considered such an investigation in connection with road design to be more urgent. Because of the small number of bridges per mile of road and the relatively small extra cost in their construction, it must be realized that the total increased cost of bridges must be a small item as compared with the increased cost of our roads to withstand the same impact.

For this reason, we have been concentrating our efforts on a solution of the problem of impact effect on road surfaces rather than on bridges. We think it important, however, to undertake impact studies on bridges and have given this subject some attention. Arrangements have now been made to measure impact stresses on bridges, making use of the strainagraph developed during the war for use on reinforced concrete ships, which apparatus has been obtained for this purpose. We plan to make a preliminary investigation on at least one bridge during he coming year.

Washington, D. C. THOS. H. MACDONALD,
Oct. 11. Chief of Bureau of Public Roads.

Urge Negative Vote on Joining Federation

Sir—Whether the American Society of Civil Engineers shall become a member of The Federated American Engineering Societies is a serious matter in view of its early decision by ballot. It may fairly be presumed that a great majority of the members of that Society would welcome such an affiliation of the four great national engineering organizations as would lead to concert of effort in all matters affecting the interests of the engineering profession, especially in its relations to public affairs. Such an affiliated organization would tend greatly to strengthen the engineering profession in this country and correspondingly advance public interests based upon or affected by engineering activities. Some such effective mode of conserving the fundamental interests of the engineering profession is urgently needed and that need has doubtless prompted the organization of The Federated American Engineering Societies, but the proposed Federation goes much too far.

All members of the four national engineering societies in this country ought to consider critically every provision of the Constitution and By-Laws of The Federated American Engineering Societies. This is no matter of professional courtesy or sentiment; it is simply the cool and impartial determination of a serious question, i.e., whether the interests of the profession will be advanced or retarded or even gravely injured by merging individual organizations in this proposed Federation.

A careful reading of the Constitution of The Federated American Engineering Societies shows that the organization is no mere affiliation designed for the purpose of securing concerted effort among individual organizations for the common good, each preserving vigorously individuality, but rather a strong, rigid organization with a Constitution and By-Laws prescribing completely what functions are to be discharged and the means provided to accomplish their full purpose. There are twelve pages of Articles of the Constitution and Chapters of the By-Laws. The object of the Federation is shown in Article II which reads as follows:

> A.—"The object of this organization shall be to further the public welfare wherever technical knowledge and engineering experience are involved, and to consider and act upon matters of common concern to the engineering and allied technical professions."

Article I, Section III of the Constitution of the American Society of Civil Engineers declares its object to be as follows:

> "Its object shall be the advancement of Engineering knowledge and practice and the maintenance of a high Professional standing among its members."

Manifestly this succinct statement of the object of the American Society of Civil Engineers is substantially identical with the expression " . . . to consider and act upon matters of common concern to the engineering and allied technical professions," each being expressed in general terms. It would be impossible for The Federated American Engineering Societies to discharge its constitutional functions without occupying the field explicitly reserved to the American Society of Civil Engineers by its Constitution, thus leading inevitably to fatal friction and disruption of the amalgamated organization. The same general observation can be made in reference to the three other national engineering societies.

The administration or management of the Federation is to be effected by "The American Engineering Council" consisting of representatives of Member-Societies. As stated in Article IV, Section 2, "This Council shall co-ordinate the activities of State councils and of local and regional affiliations whenever these activities are of national or general importance or may affect the general interests of engineers."

The actual management is carried on by an Executive Board acting under the direction of the Council. If co-ordination means anything in this connection, it means the regulation of the general affairs of the Member-Societies. In other words, the Member-Societies are to be substantially regulated and controlled in their principal or general activities. There is no escape from this conclusion unless the Federation becomes supine and nerveless in the functions which its Constitution and By-Laws prescribe. These functions are in the main those which the National Engineering Societies are already performing and have been performing for many years, but which the Federation now requires them to assign to it while they in turn are to divest themselves of their original individualities and place themselves under the management of the American Engineering Council acting through its Executive Board.

In Article IV it is prescribed to "be the duty of the American Engineering Council to interest itself in the activities of local and regional organizations and affiliations and state organizations and councils if such activities are of national scope, or affect the general interest of the engineering and allied technical profession." This means that even local affairs as well as those of the state are to come within the consideration of the Council, as it would be difficult to find any engineering matter or activity which could not be so interpreted or shaped as to "affect the general interests of the engineering and allied technical profession."

Article VI provides funds by assessments upon Member-Societies, at the rate of $1.50 per member annually. At the same time there is no provision in the present referendum for obtaining these funds from the membership of our Society. The recent favorable vote on constitutional amendment to increase the dues will furnish only the necessary revenue to meet current expenses of operation and there is no available source of income to meet this proposed additional assessment. One of the most objectionable features

about this whole matter is to be found in Chapter I, Section 1 of the By-Laws, which reads as follows:

> B.—"Qualifications: Any society or organization of the engineering or allied technical professions whose chief object is the advancement of the knowledge and practice of engineering or the application of allied sciences and which is not organized for commercial purposes, is eligible for membership."

This provision expressing the required qualifications of Member-Societies is certainly broad and liberal enough to take in any organization from the four great national engineering societies down to a Carpenters' or Plumbers' Union, as the latter are not organized for commercial purposes and they have for their purpose among other things the advancement of the application of allied sciences. The latter organizations are excellent and accomplish much good when managed in a sane and reasonable way, but they would scarcely make a suitable and harmonious combination with the American Society of Civil Engineers or with the other National Societies. The application of these qualifications for membership would bring together a destructively heterogeneous gathering of a great variety of organizations with a wide range of objects, different ideals and a diversity of interests so intrinsically conflicting as to breed incurable dissension.

These critical considerations could be much extended to cover other objectionable features of the proposed Federation, but enough has been shown to demonstrate conclusively the unwisdom and unworkability of the contemplated organization. The four National Engineering Societies at least should form some effective affiliation for the common good whenever important measures need concerted action without in any way trenching on the individual activity of each. The creation of such an affiliation is perfectly feasible, although requiring the deliberate and careful consideration of each organization. Such an undertaking is worthy of the best efforts of the broad minded, experienced members of each Society.

In the meantime, the proposal to enter The Federated American Engineering Societies should be defeated.

WILLIAM H. BURR,
J. VIPOND DAVIES,
ALLEN HAZEN,
ALEXANDER HUMPHREYS,
HENRY R. LEONARD,
SAMUEL REA,
J. WALDO SMITH,
WILLIAM J. WILGUS.

New York, Oct. 25.

Am. Soc. C. E. Should Join Federation, Says G. S. Williams

Sir—A member of the American Society of Civil Engineers has well said: "In order to make most effective the influence of that sound engineering service and guidance to which the public is justly entitled, and to improve the agencies through which the combined intelligence and genius of American engineering may express itself, the outstanding need of our profession today is its unification through a central representative body."

To meet this need the Federated American Engineering Societies has been formed, and in that specification lies the essential and a very distinct difference between it and the American Association of Engineers. The American Association of Engineers has for its primary object service to the individual, its member; the Federated American Engineering Societies has for its primary object service to the nation, the state and the municipality. With these distinct aims there is no reason to anticipate antagonism between the two, but rather, in matters of common interest, co-operation. In this distinction lies the justification, abundant in the writer's opinion, for the two organizations being separate bodies rather than united as one.

It is difficult to understand the opposition to the Federated American Engineering Societies on the part of men who have distinguished themselves in the work of civic betterment in their own communities, unless they have overlooked the underlying purpose of the organization as set forth in the second paragraph of its constitution which reads:

> A service to others is the expression of the highest motive to which men respond and as duty to contribute to the public welfare demands the best efforts men can put forth, NOW, THEREFORE, the enginering and allied technical societies of the United States of America, through the formation of the Federated American Engineering Societies, realize a long cherished ideal, a comprehensive organization dedicated to the service of the community, state and nation.

The name and prestige of the American Society of Civil Engineers are dear to all its members, but what is in a name and what is prestige? Many a splendid name has gone to oblivion by the failure of those who bore it to measure up to the standard set before them—and prestige is defined as "an illusion."

There was a time when the American Society of Civil Engineers stood at the head of our engineering organizations and was looked up to by the whole profession in America, but that time has past. The opportunity to continue in that exalted position was thrown away by the provincialism of the governing minority and for ten years the society has done practically nothing for the profession, for its members or for the nation (except as a publication house at an exhorbitant cost), while other societies, both the Mechanical and the Electrical Engineers, if not also the Society for Testing Materials, have far outstripped it in the esteem of the profession and the public. Perhaps as suggested in a recent communication in your journal "*the standing of the American Society of Civil Engineers in the eyes of the world is a valuable professional asset*," but it is nevertheless a "*standing-still*," a mausoleum to the shortsightedness of those who have controlled and, in spite of an adverse majority, still seek to control its policies.

The arguments advanced by the committee against joining the Federated Societies are almost all counterparts of those to be found in the speeches of Melancthon Smith in the New York Convention of 1788, against the adoption of the Federal Constitution, but time has shown the fallacy of his reasoning, just as time will show the fallacy of that of the committee.

If the American Society of Civil Engineers is to play its part or any important part in the solution of the great problems today before our nation it must put its shoulder to the wheel of service with its sister organizations, and take its chance of a few blisters and callouses with the rest. If it is not willing to play such a part it has no right to the name it now holds, nor can it expect to retain the respect and support of its public-spirited members.

GARDNER S. WILLIAMS,
Consulting Engineer.

Ann Arbor, Mich., Oct. 23.

Edwin Thacher and the Straight-Line Formula

Sir—In your issue of Sept. 30, p. 675, there is a biographical sketch of Edwin Thacher, whose professional services throughout a long life were so eminent as to deserve richly the memorial. I write this after many years of cordial friendship with him, the memory of which I shall always cherish. There is, however, one statement by the writer of the biography which is not in accord with historical accuracy and I doubt much whether Mr. Thacher himself would sanction it.

In speaking of the "notable achievements of his career," it is stated that they include "the deduction of the straight-line formula (in the publication of which, however, he was anticipated by Thomas H. Johnson, who had been independently studying the subject at the same time as Mr. Thacher)." This is a fundamental error in the history of the straight-line formula, as the establishment of that formula was due neither to Mr. Thacher nor to Mr. Johnson, and in all my long acquaintance with the former I never heard him make such claim or even intimate it. Curiously, the straight-line formula has for a considerable number of years been rather often called the "Johnson formula," although not generally.

The circumstances under which the formula originated, as any one can determine for himself, are as follows: At the annual convention of the American Society of Civil Engineers at Washington, D. C., in June, 1881, the old

bridge-building firm of Clark, Reeves & Co., of Phoenixville, Pa., presented a paper on the ultimate resistances of a series of wrought-iron Phoenix columns, the actual tests having been made at the Watertown Arsenal, Watertown, Mass. In the discussion of these tests the straight-line column formula was first set forth independently by each of three members of the American Society of Civil Engineers, Charles E. Emery, Prof. Mansfield Merriman and myself. Mr. Emery's discussion simply called attention to the straight-line character of that portion of the experimental curve of resistances which included the lengths of columns used in ordinary structural design, at the same time exhibiting in his discussion the equation of a straight line, but not in terms for immediate practical application. Prof. Merriman and I set forth rather extended discussions showing over what part of the experimental curve the straight-line formula would find application. He expressed the formula in terms of length over diameter of column, but my discussion presented the formula in terms of length over radius of gyration, the form in which it has ever since been used. My discussion, therefore, gave for the first time the straight-line formula in the form in which it has come into general use.

I am aware that it is not a matter of material consequence who first proposed and used the straight-line formula, but it is worth while in the interests of historical accuracy to record the facts as they are.

The paper to which I have referred above is entitled "Experiments Upon Phoenix Columns" and is found in Vol. XI, 1882, *Transactions* of the American Society of Civil Engineers. The discussions showing the straight-line formula are found on pages 93, 111 and 115.

Mr. Johnson's paper can be found in the *Transactions*, Vol. XV, 1886, p. 517. He, therefore, had before him for a period of four years the establishment of the straight-line formula before the appearance of his paper on the same formula. Although the straight-line formula is purely empirical and not subject to analytic derivation, he attempted to establish it by analytic demonstration, an effort which could not result successfully. An analytic demonstration based even partially upon the common theory of flexure cannot correctly be applied to members like long columns which are tested far beyond the elastic limit, although it may be done as an approximate analysis to which empirical co-efficients may be fitted by tests for ultimate resistance.

WILLIAM H. BURR,
Consulting Engineer.

New York City, Oct. 21.

Simple Formulas for Bond Stress Limits in Concrete Beams

Sir — For figuring bond stress in reinforced-concrete beams of uniform loading the writer suggests the following method as handier than the usual one of solving for u in the formula:

$$u = \frac{V}{\Sigma O . jd}$$

Given an area of steel required for moment, the smaller the individual bar, the greater the total surface for bond. That size which is sufficient for moment and small enough for bond varies directly with the length of span, according to the following relations:

$c = \frac{l}{200}$ = Simple Beam

$c = \frac{l}{100}$ = Cantilever Beam

$c = \frac{l}{250}$ = Continuous Beam of Two Spans

$c = \frac{l}{200}$ = End Supports of Continuous Beam of Many Span.

$c = \frac{l}{300}$ = Elsewhere in Continuous Beam of Many Spans

where c = maximum size of bar—
and l = span in inches.

This may be proved as follows:

Σa_s = steel used for moment.

$$= \frac{M}{f_s . jd}$$

Also, $u = \frac{V}{\Sigma O . jd}$ (where ΣO = total circumference of bars).

or, $\Sigma O = \frac{V}{u . jd}$

But, for either round or square bars,

$\frac{\Sigma a_s}{\Sigma O} = \frac{c}{4}$ (where c = size of average bar).

$$= \frac{M}{f_s . jd} \cdot \frac{u\,jd}{V} = \frac{c}{4}$$

or, $c = \frac{M}{V} \cdot \frac{4\,u}{f_s}$

Allowing $u = 80$ and $f_s = 16{,}000$ lb. per square inch. Then for a simple beam—

$$\frac{M}{V} = \frac{wl^2}{8} \times \frac{b}{\frac{wlb}{2}} = \frac{l}{4}$$

and $c = \frac{l}{200}$

The other derivations are similar:

CHARLES E. SHARP, JR.

St. Louis, Mo., Sept. 30, 1920.

Factors Affecting Use of Water in Irrigation

Sir—In your issue of June 10, 1920, is a valuable article by E. A. Moritz entitled "Factors Affecting the Use of Water in Irrigation." The data furnished by Mr. Moritz do more than what he says that he hopes to do, i. e., "throw an increment of additional light on the subject." The author, however, does not attempt to answer, even in general terms, the question editorially asked, "What is the maximum area which a given water supply will irrigate?", appreciating the fact that volumes written about irrigation engineering could not answer the question completely, for, as he well says, "It is obviously impossible to duplicate any given set of conditions."

However, in view of the fact that "a new irrigation development is nearly upon us," as is suggested, "engineers should have the benefit of the widest available information," from whatever source it may be obtainable, and any engineer of experience should be glad to share with others the conclusions derived through that experience. Therefore, since a study of the subject during a period of over thirty years, in the course of which time reports have been made concerning proposed irrigation projects scattered throughout the entire so-called arid and semi-arid parts of the United States, has led to certain conclusions which may be of interest to others, at least as bases for discussion, the writer ventures to present them herein. It is, of course, impossible to go into the details as to the reasons for these conclusions, or even to state them in full, in a letter of this character, but it is hoped that it may, nevertheless, be worth while to attempt to outline them in brief.

In the past, even under the most favorable conditions as to water supply, irrigation companies, districts, canal owners, etc., have generally been individual entities, fighting all others dependent upon the same source of supply for their "rights" to water, shotgun control being exchanged slowly for regulation by properly constituted legal authority. The coming era may, perhaps, be an era of co-operation in which the general aim will be to utilize to the greatest possible extent all, or as much as it is practicable to use, of the available supply of a given stream system, or even a combination of stream systems, recognizing the fact that, generally speaking, the supply of arid land far exceeds the available supply of water. To illustrate, the writer selected, nearly twenty years ago, two projects for U. S. Reclamation

Service, both of which have since been constructed. One of the primary reasons for selection in each case was the fact that it was believed that the available water supply, with storage as it might be needed, would always be adequate, practically regardless of what those having so-called priorities in the stream system might do. The most recent reports have been designed to make the fullest possible use of all of the practically available supplies, through a consolidation of all the interests in water within the given watershed, regulating the annual flow and conserving the floods through storage, utilizing both the normal underground supplies and the recovered waters originating from the surplus water used in the original distribution and application, so far as such utilization may be found to be practicable, the fact being now generally recognized that apparent losses in greater or less amounts, depending upon existing conditions, are inevitable and may even be necessary to achieve the desired result, i. e., the profitable production of crops.

It is obvious that "a given water supply," when uncontrolled or unregulated by storage, will efficiently irrigate only the minimum area. With storage and regulation, a greater area, and through the addition permitted by the recovery and utilization of the available underground supplies to the fullest extent possible, a still greater area, approaching a maximum, may be irrigated, the results being also modified and limited by the ratio of cost to returns. It is the practice of the writer, when attempting to arrive at a tentative conclusion as to the maximum area that can be effectively supplied with water, in cases where it is planned that the most complete use possible shall be made of the water supply, to follow a method, which, reduced to the form of an equation, is as follows:

$$A = C\frac{S + U + R + P - L}{D}$$

where

A represents the area sought, expressed in acres.

C is a coefficient varying inversely with the completeness of the irrigation of the district, taking into consideration the following factors: (a) The area irrigated the first year will be relatively small; (b) Development of irrigation to the maximum amount will require several years, the length of the term depending upon local conditions; (c) The area actually irrigated will in no given year be more than a certain percentage, also more or less dependent on local conditions, of the entire area within the district—as only a certain percentage of all of the good agricultural lands in any given county or township in humid territory is cultivated in any one given year. In very large projects, generally speaking, from 60 to 80 per cent appears to be about the range of reasonable probability as to the maximum, with smaller amounts in the earlier stages of operation, C being the inverse of this estimated percentage.

S is the measurable (and, for final estimates, at least, reasonably well known, not guessed or estimated from precipitation, drainage area, etc.) dependable surface run-off of the stream system, expressed in acre-feet, modified in accordance with known practicable storage and regulation possibilities. It is obvious that the determination of bases that would warrant final conclusions must involve definite knowledge of actual run-off, availability and efficiency of storage sites, evaporation, seepage and transmission losses, existing rights, etc.

U is the normal underground supply, expressed in acre-feet, that is being or that may be profitably drawn upon and added to the surface supply. This factor would generally have to be estimated after a study of local conditions had been made.

R is the practically recoverable and usable parts of the delivery and application surpluses, expressed in acre-feet. It will vary with many conditions, such as nature of reservoir bottoms and sides, dams, geology, soils, canal surfaces, distance water has to be conveyed, efficiency of application, etc. Mr. Moritz suggests from 25 to 50 per cent of the total entering the headgate as the probable range of gross loss. It will obviously be some derivative of the sum of S, U and itself. In this connection it should, perhaps, be stated with reference to the control of the underground waters that the best modern practice tends to a recognition of the fact that plans for an irrigation system should also include provision for drainage, the details to be worked out as conditions may be evolved. Unless the ground water levels are controlled large tracts of land, perhaps originally considered the best in the district, will become water-logged and perhaps permanently ruined.

P is the amount of precipitation beneficial to agriculture, expressed in acre-feet. It may or may not be important, the conditions varying in different localities.

L is the amount of water, expressed in acre-feet, that is definitely lost beyond recovery or that becomes too alkaline or otherwise bad to be used for irrigation.

D is the ultimate duty of the water, i. e., the number of acre-feet capable, on the average, and considering all the acres irrigated within the district, of producing the most satisfactory results. It must not be confused with the amount from which transmission losses are to be deducted, since such losses are otherwise provided for in the formula, but is simply the amount actually required at the place of application for transpiration and evaporation. Reliable investigations have sometimes shown it to be as low as two, and where the return waters are used over and over, even one acre-foot per acre.

One example of the formula, with estimated values, as used in practice in one instance, is as follows:

$$\underset{(C)}{\frac{4}{3}} \times \frac{\underset{(S)}{825{,}000} + \underset{(U)}{100{,}000} + \underset{(R)}{200{,}000} + \underset{(P)}{0} - \underset{(L)}{125{,}000}}{\underset{(D)}{10\ 3}} = \underset{(A)}{400{,}000}$$

In this example the estimate for C was based on a study of the history of somewhat similar large projects, for S on authentic records covering a period of 24 years, for U, R and L on studies of local conditions, and for P on U. S. Weather Bureau records. P was ignored as being too small and erratic to be taken into consideration, though in actual practice in that particular region it is usually thought to be at least the equivalent of a winter irrigation. D, based on local requirements, is probably large but the intent was to make the estimate, a preliminary one, very conservative. Due weight, must, of course, be given to uncertainties, irregularities of supply, etc., but generally speaking, where conditions are reasonably well understood, it is a mistake to lean too strongly to the side of conservatism, as the practicability of the undertaking from the standpoint of the ability of the project to repay the cost is likely to depend upon the inclusion of as much new land as can certainly be furnished with enough water. Certainly the aim of the engineer should be to make his preliminary estimate as nearly "right" as possible.

It is obvious that when no storage or use of underground waters is contemplated the formula becomes

$$A = C\frac{S + P - L}{D},$$

S becoming, in this case, that portion of the surface supply practicably and advantageously available, taking the monthly records and requirements into consideration along the lines suggested by Mr. Moritz, the other factors remaining as before. Of course there may also be an infinite number of intermediate situations, a different analysis being required in each case. A will sometimes be limited to the existing area of good land and P may often be eliminated through it should always be studied.

Only the relationship of water supply and land has thus far been considered. Estimates of cost, ability of the land to repay the cost with a good margin of profit, financing, settlement, etc., must follow the original tentative estimate of area. Every experienced engineer will have his own method of going about this. The writer generally uses approximately the following skeleton outline of a plan of investigation and reporting:

Location: availability of labor and labor-saving machinery.
Description: historical statement; general plan.
Climate: its general suitability for human habitation and agriculture.

Lands: geology, topography, altitude, extent, soils, crops, markets, transportation facilities, ownership and other conditions affecting the practicability of the undertaking.

Water Supply: amount and suitability for the irrigation of the lands, including all the factors used in the formula previously described.

Cost: preliminary investigations, surveys, financing, construction, settlement, overhead expense, and everything incidental thereto.

Economic Practicability: the capacity of the lands for paying the charges that must be made to cover maintenance and operation and the repayment of the original cost with interest, and adequate returns with profit to the farmers.

The writer considers the general plan as suggestive rather than otherwise but hopes that its presentation may induce further discussion. It might be stated, further, that detailed, checked, verified and revised estimates should be made before final conclusions, even concerning A, are reached.

A. LINCOLN FELLOWS,
Senior Irrigation Engineer, Division of Irrigation, Bureau of Public Roads, U. S. Department of Agriculture.
Denver, Col., Oct. 15.

Depths of Concrete Footings

Sir—In order that there may be no misunderstanding, it might be well to note that the d in the diagram on formula on p. 464, *Engineering News-Record*, Sept. 2, 1920, in my article entitled "Practical Design of Concrete Cap Footing" should be the effective depth of the footing slab, that is the depth from the top of the slab to the center of the reinforcing steel.

Chicago, Ill., Oct. 9. H. H. FRENZEL.

Takes Exception to Utility of Venturi Flume

Sir—I have read with much interest the article by Messrs. Wilson and Wright on "A Study of the Venturi Flume as a Measuring Device in Open Channels," published in *Engineering News-Record*, Sept. 2, 1920. I do not wish to criticize the experiments as carried out in the Cornell laboratory, which appear to have been conducted in an academic and scientific manner. There are, however, several statements in the text to which, I believe, many hydraulic engineers will take exception.

The authors say of the Venturi flume: "It will combine, under field conditions, accuracy at least equal to that of any other open-channel measuring apparatus, together with reliability and small loss of head in the channel." Usually under field conditions, in the West, the gages are read by ditch riders who are rarely able to read a gage closer than 0.01 ft. In the Venturi flume two readings have to be taken, each of which, under field conditions, are likely to be in error 0.01 ft. Consequently, the Venturi difference h could easily be in error 0.02 ft. Referring to Fig. 5 of the article, it can be seen that an error of 0.02 ft. would cause an error in the discharge of from 25 to 50 per cent. Besides the probable error due to reading the two gages there is a constant error due to the inaccurate coefficient C_f which, according to the authors' statement, is about 5 per cent.

The authors' statement, "The Venturi flume has been demonstrated to be a means of measuring water with an accuracy about equal to that of the ordinary weir in practice" cannot pass unchallenged. The classical experiments of Francis, Bazin, Lyman, Thompson, Barr and others all indicate that with a properly constructed weir the error by formula will be within 2 per cent of the actual discharge. Moreover, the relative error due to field observations of gage height will not be in excess of 0.01 ft. Let us assume that a channel is being measured by a right-angled notch weir, the formula in the case being $Q = 2.52\ H\ 2.47$. With a head of 1.10 ft. the discharge is 3.189 sec.-ft. and with a head of 1.11 ft. it is 3.261 sec.-ft., giving a difference in discharge of 0.072 sec.-ft., or 2.2 per cent, which is a considerably smaller error than could be expected by the Venturi flume.

The writer, sometime manager and engineer for various Western irrigation projects, has had considerable opportunity to test out the accuracy of the ordinary Price current meters. He has found when gaging flumes are rated by means of a current meter, that an accuracy of from 2 to 5 per cent may invariably be obtained. The lost head in a gaging flume is far less than that in a Venturi flume, and also the cost of construction would be considerably less.

It is hardly to be expected that any project engineer would install a Venturi flume and be satisfied to use a laboratory formula in computing the discharge. The friction factor and the coefficient C_f of the field flume would undoubtedly be different from that of the smaller laboratory model. The Venturi flume, to be of practical service, should be rated in the field with a current meter, and since an equally accurate rating curve can be obtained for a rectangular flume of constant cross-section there would be no object in adopting the more expensive and complicated measuring device.

Weirs of all types have been used very successfully on irrigation projects. Over 5,000 small weirs are used on one Western project alone. The lost head resulting from the use of weirs is, in many cases, an actual advantage. A majority of the weirs are placed at the turnouts of the main canals or laterals, at which points there is generally an excess of head to be dissipated.

Even the small lost head of the Venturi flume would hardly be permitted in low-head power projects when the flow could be measured more accurately without obstruction by means of a current meter or by Chemi-Hydrometry. B. F. Groat, in his paper on Chemi-Hydrometry, Vol. LXXX, Trans. Am. Soc. C. E., 1916, claims an accuracy of a fraction of 1 per cent by the chemical method of gaging. In an article on the "Characteristics of Cup and Screw Meters," Vol. LXXVL, Trans. Am. Soc. C. E., 1913, Mr. Groat remarks in regard to current meter gagings: "Good work on the mountain streams of North Carolina and Tennessee has shown that individual discharge determinations based on the foregoing processes will plot within 1 or 2 per cent as extreme errors, of the final discharge curves."

The writer has repeatedly checked current meter discharges against that of a standard weir, the difference being generally under 3 per cent.

I am of the opinion that an effort should be made toward simplicity in the design of all gaging devices. Unfortunately the modern hydraulician is constantly striving for something new and, in doing so, frequently creates a complicated laboratory device, and overlooks the necessity for the practical application of the same.

Anaconda, Mont., Sept. 9. H. L. THACKWELL,
Hydraulic Engineer.

The Spreader Plow for Railroad Embankment

Sir—Referring to the comments of L. C. Scott in *Engineering News-Record*, Sept. 2, p. 473, in connection with the use of a spreader plow in building high banks in railroad construction work, (*Engineering News-Record*, Aug. 12, p. 229), his statement that such a method would interfere with uninterrupted service is true. Where space is limited and service must be maintained this method could not be used to advantage. However, where sufficient space is available the method described has been used and has effected an enormous saving as compared to what trestle work would have cost. Some material will roll down from the high position of the track as suggested by Mr. Scott, but not to so great an extent as to be serious.

South Milwaukee, Wis., Sept. 30. MARK J. WOODHULL.

Large Gas-Welded Tank for Compressed Gas

A tank 22 ft. in diameter by 30 ft. high, for compressed gas, has just been completed at the plant of the Liquid Carbonic Co., Birmingham, Ala. It consists of ¼-in. steel plates joined at the seams by oxyacetylene welding. After completion it withstood the proof test and was found to be gas-tight in all the seams.

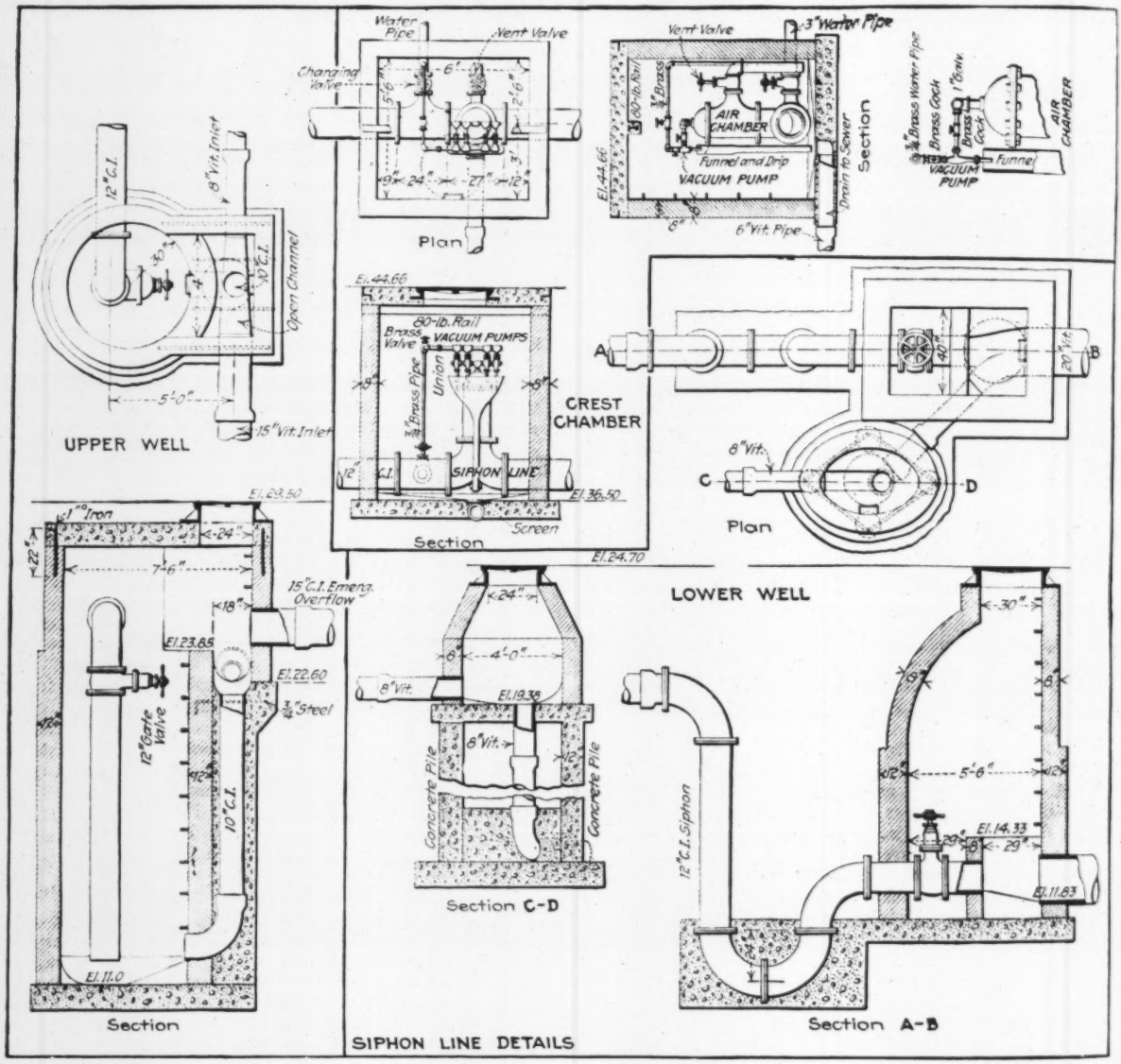
True Sewage Siphon With Water-Jet Ejectors on Air Chamber

Sir—In connection with the article in your issue of Sept. 16, describing the installation of an electrically-operated pump to remove accumulated air from the crest of a true siphon, and a letter published Sept. 30, suggesting the use of a venturi tube for maintaining the requisite vacuum, your readers may be interested in the accompanying plan showing a true siphon which I designed in 1907 to carry clarified sewage from a high but pocketed district of East Providence, R. I., to the main gravity system of the town.

The siphon is of 12-in. cast-iron pipe. Both ends are water-sealed—the intake by submerging the pipe to an elevation lower than the spill of the discharge, the outlet by a return bend. Even when operation ceases entirely, the siphon can draw no air from either end.

At the crest an air-chamber is provided, and to the crown of this is connected a battery of four water-jet ejectors (in multiple merely to guard against obstruction of one or more units between visits of inspection), operated by $\frac{1}{16}$-in. jets from the water main in the street. The operating water and the small amount of sewage entrained when all air has been removed from the chamber are discharged directly into the shallow local sewer which serves the houses on the hill.

The siphon is charged thus: First, the intake well is filled to the level of the valve controlling the intake pipe. This valve and a similar valve at the outlet end are then closed, an air-vent at the crest is opened, and water from a 3-in. connection with the water main is turned into the siphon. When full, the water valve is closed, the outlet valve is opened, the intake valve opened and the battery of ejectors started.



TRUE SEWAGE SIPHON AT EAST PROVIDENCE, R. I.

The velocity of flow is governed entirely by the amount of sewage entering the upper well. No throttling is needed. If a sudden rush of local sewage brings a volume greater than that being removed by the siphon at the head momentarily existing, water will rise in the intake well and increase correspondingly the head and the velocity through the pipe.

If it diminish, the discharge will slacken; it may cease altogether without breaking the siphon.

The admitted waste of water is, in the judgment of the writer, much more than offset by the low cost of installation and maintenance and the entire absence of moving parts.

G. EVERETT HILL.

New York City, Oct. 8. City Wastes Disposal Co.

NEWS OF THE WEEK

New York, October 28, 1920

Federation Endorsed by 455 Am. Soc. C. E. Members

Circular Letter Issued This Week Urges Affirmative Vote on Ballot To Be Canvassed Nov. 8

Carrying the names of 455 corporate members, a circular letter urging an affirmative vote on the proposal to join the Federated American Engineering Societies was sent this week to the membership of the American Society of Civil Engineers, by whom the question will be decided by letter ballot to be canvassed Nov. 8. After recording the endorsement of the federation by Engineering Council and the Washington Organizing Conference the communication presents arguments in favor of charter membership in the federation for the American Society of Civil Engineers.

The letter is reprinted in full below:

We fully endorse the arguments for joining the Federated American Engineering Societies. We are impressed that the unanimous recommendation of the Joint Conference Committee of the four Founder Societies (Sept. 17, 1920) of a comprehensive engineering organization, received the unanimous endorsement of

(a) Engineering Council (October, 1919),

(b) The joint meeting of the governing boards of the Am. Soc. C. E., Am. Inst. M. E., Am. Soc. M. E., Am. Inst. E. E., Am. Soc. T. M., U. E. S., and the members of Engineering Council (Jan. 23, 1920), and

(c) The Washington Organizing Conference (June 3-4, 1920),

and led to the unanimous creation of the Federated American Engineering Societies and American Engineering Council (June 3-4, 1920), which were unanimously endorsed by Engineering Council, June 17, 1920. The Chairman of Engineering Council advised the Joint Conference Committee on July 12, 1920, that it would act for the new Council and do everything in its power to facilitate a smooth transfer of activities from the old to the new Council (Jan. 1, 1921).

This movement does not embark the society either on a "highly questionable" or "dangerous" procedure or "carry it abruptly into untried paths," nor does it mean the "surrender of the society's name and prestige," since it is a continuation, on a more representative and democratic basis, of the work of Engineering Council, in the organization of which the society participated and has fostered and financially supported for over three years.

(*Continued on p. 866*)

Business Stagnation Reduces Steel Prices in Germany

(From Engineering News-Record's Berlin Correspondent)

Business stagnation in Germany has considerably eased the iron and steel markets and has lately resulted in an all-round reduction of iron and steel prices for raw and semi-finished products. Scrap iron, which was at its highest point in March, at 2,100 marks, is now freely offered at 500 marks and still the supply overlaps the demand. Prices for semi-finished products, which were at their highest point in May, 1920, have now returned to the level of February, 1920. The August quotation of structural shapes was 2,740 marks, as against a high quotation of 3,620 marks in May, 1920. Structural shapes were offered at 220 marks in December, 1918. Steel bars were offered in August at 2,840 marks, as against 3,200 marks for June and 3,650 marks for May. Bars were quoted at 135 marks in December, 1915. Price quotations here are per thousand pounds.

As Germany is now mostly dependent on foreign countries for the supply of iron ore, the prices will naturally move in accordance with the fluctuations of the exchange. The only stabilizing factor in this respect is the scrap iron, which still forms a large part of furnace supplies. The supply of scrap is by no means exhausted and is considerably helped now by the scrapping of war material. Lately, over 500 airship sheds and airdromes, estimated to contain more than 300,000 tons of steel, have been designated to be scrapped. Also there are stores of ammunition, rifles and ordnance in the country which the Reparation Commission will soon put on the scrap market.

New Member for Federation

The Washington Society of Engineers has voted to accept the invitation to become charter members of the Federated American Engineering Societies. At a recent meeting R. L. Humphrey explained the advantages offered to members of the federation. A. P. Davis, George R. Putnam and M. O. Leighton urged that the invitation be accepted. While some arguments in opposition were presented sentiment was overwhelmingly in favor of accepting membership.

Federation Opposed

A vote of the executive board of the Illinois Society of Engineers was 9 to 1 against joining the Federated American Engineering Societies, but no definite action has been taken. The matter may be submitted to a vote of the members.

Discuss Steam and Electric Locomotives

Relative Merits Considered at Meeting of Engineering Society Sections Last Week

The relative merits of modern steam and electric locomotives were discussed Oct. 22 at the first joint meeting of the Railroad Section, Am. Soc. M. E., the Metropolitan Section, Am. Soc. M. E., and the New York Section of the Am. Inst. E. E. The principal papers presented were by John E. Muhlfeld, Railway & Industrial Engineers, Inc., New York; F. H. Shepard, director of heavy traction, Westinghouse Electric & Manufacturing Co., and A. H. Armstrong, chairman, electrification committee, General Electric Co. Abstracts of these three paper appear elsewhere in this issue.

The meeting was held in the auditorium of the Engineering Societies Building and the attendance overtaxed its capacity. The program was presented under the direction of E. B. Katté, chairman of the Railroad Section, Am. Soc. M. E., H. W. Buck, chairman of the New York Section, Am. Inst. E. E., and W. S. Finlay, Jr., chairman of the Metropolitan Section of the Am. Soc. M. E.

The discussion was opened by Frank J. Sprague, who was introduced by the chairman as the "father of electric traction." Mr. Sprague briefly reviewed the remarkable development of steam railroad electrification and pointed out that present conditions, for purposes of increasing traffic and power, demanded the concentration of power represented by electrification, together with increased speed. He said that electrification would come gradually and would be governed largely by financial conditions, but that by electrification only will maximum traffic capacity of trackage be secured. Following the papers of Mr. Muhlfeld, Mr. Shepard and Mr. Armstrong, the discussion was continued.

In a paper by F. J. Cole, chief consulting engineer, Locomotive Superheater Co., read by H. B. Oatley, chief engineer of the same company, the statement was made that further refinements of the steam locomotive should be able to equal past performance. In any comparison of maintenance cost the comparative costs of the maintenance of all electrical as well as all steam equipment must be considered. The complete cost of electrification is hard to obtain in full.

A. W. Gibbs, chief mechanical engineer, Pennsylvania System, who has had charge of electrification at New York and Philadelphia, pointed out that

it was desirable to unify speeds of both passenger and freight service in order to increase the traffic capacity of trackage. Mr. Gibbs conceded that standby losses of steam locomotives are considerable. In his opinion it is useless to attempt comparison of relative maintenance costs since the necessary data have not been developed by experience. Local conditions must always determine whether electrification is to be resorted to.

The cost of maintaining electrical equipment is comparatively high according to the statement made by F. H. Hardin, chief engineer of motive power and rolling stock, New York Central R.R., in a paper read by R. M. Brown, engineer of motive power of the same road. While it is stated that there is no need for back shops for electric locomotives, wrote Mr. Hardin, shops whether called back shops or by some other name will be required. On the New York Central R.R., in one estimate, equated costs per mile for repairs to a Mallet locomotive and the electric locomotive showed 37c. for the Mallet and about 60c. for the electric locomotive. It was stated that electrification will be a part of the solution of developing railroad capacity, but is only one factor and perhaps not the greatest involved in accomplishing what Mr. Shepard pointed out for the future.

Range of Operation

That the steam locomotive could be made to do all that had been claimed by Mr. Shepard for the electric locomotive as to range of operation was a statement included in a paper by W. F. Kiesel, Jr., mechanical engineer, Pennsylvania R.R., which was read by title.

W. L. Bean, assistant general mechanical superintendent, New Haven R.R., emphasized the relatively high maintenance cost of electric locomotives; danger from overheating from repeated acceleration, and effects on insulating material.

In behalf of the electric locomotive, C. H. Quinn, chief electrical engineer, Norfolk & Western Ry., said that on that road it had not been necessary to install any system of power limiting by dispatching and that the only signaling that was used to dispatch trains is ordinary block signaling. However, the future possibilities of the steam locomotive to keep up to the demands of power and speed should be looked into with due regard for limits of clearance and wheel loading. He said that the Norfolk & Western over its electrified area was now carrying 100 per cent more tonnage than was previously possible.

A. L. Ralston, mechanical superintendent, New Haven R.R., cited successful experience with electrification on the New Haven. A paper written by Reinier Beeuwkes, electrical engineer, Chicago, Milwaukee & St. Paul R.R., described the successful operation of electric locomotives on that road and stated that as a result definite information and cost data had been established. "In any event," said Mr. Beeuwkes, "actual available operating data will permit of settling the matter one way or the other in the individual case." The case for the electric locomotive was summed up by E. B. Katté, chief electric engineer, New York Central R.R., who said that electric locomotives on that road were ready for service 56.2 per cent of the time and steam locomotives only 24.3 per cent. Mr. Katte pointed out wide difference in fuel consumption on different electrifications.

Building Construction Disclosures at New York

With a view to determining the extent to which the action and practices of building-material interests and contractors have prevented building on a larger scale in the State of New York, an investigation is now under way in New York City by a legislative committee, with Samuel Untermyer acting as its counsel. Specifically the committee was ordered by the legislature to determine whether a "building-materials trust" was putting up the price of materials or otherwise interfering with the volume of construction work.

The disclosures so far made, and to which importance is attached by the counsel of the committee, relate to the activities of an attorney, one John T. Hettrick, in "advising" contractors whether or not to bid on certain jobs; to the simultaneous retainer of Hettrick by the labor unions, and to a bribe alleged to have been given by a contractor in order to have a strike "called off" promptly.

"Advice" Given on Bids

Hettrick, it appears, acted as adviser of a number of plumbing contractors. These contractors sent him copies of bids they proposed to submit, and he, in turn, "advised" them with reference to the client's credit, the conclusion being drawn by the counsel of the committee that that advice was a ruse to control the bidding figure and bring about collusion.

Later in the investigation there was introduced in evidence a letter written by Hettrick to the Mayor of New York, urging him to facilitate the starting of work upon certain contracts for the building of the new Court House. In it was a closing paragraph in which he stated that he represented a number of the unions. Attempt is being made to indicate that Hettrick, counseling both the contractors and labor, was in a position to materially affect the prosecution of building work.

Attempt is being made by Mr. Untermyer, also, to run down the story of the alleged bribe for the cancellation of a strike against a building contractor.

As a result of the disclosures so far made, the Mayor of New York has cancelled the contracts already let upon the new Court House, totaling about $6,000,000.

New York Engineers Consider Civic Subjects

First Meeting of Am. Soc. C. E. Local Section Devoted to Freight-Handling Problem

The first of a series of eight meetings devoted to the discussion of important civic subjects that affect the future well being of the New York Metropolitan district was held by the New York Section of the American Society of Civil Engineers, Oct. 20, and was devoted to a consideration of the subject, "Local Distribution of Freight and Food Products." Colonel Charles D. Hine, special agent, Erie R.R. at New York, who was previously vice-president of the Southern Pacific Railroad Co. of Mexico, was the principal speaker. It is the plan of the local section that the discussion at these meetings will result in recommendations and definite plans for action on the subjects under consideration.

Colonel Hine, in discussing the problem of distribution and freight handling in the port of New York, laid emphasis on the need of providing prodigious expansion of storage facilities and expediting the short haul in small workable units. Extracts from his paper appear elsewhere in this issue. Colonel Hine was followed by Colonel F. A. Molitor, who managed the Citizens Trucking Corporation during the strike of coastwise freight handlers; J. Shirley Eaton, of the Federal Trade Commission; Cyrus C. Miller, formerly president of the Borough of The Bronx; E. C. Church, of the New York Chamber of Commerce; J. J. Hallihan, J. B. Miller, assistant corporation counsel, New York City; B. F. Fitch, president of the Motor Terminals Co., New York and Cleveland, which has the contract with the railroads entering Cincinnati for the handling of transfer freight at that point in demountable motor truck bodies; Fred Lavis, consulting engineer, American International Corporation, New York, and W. C. Brinton, consulting mechanical engineer, New York.

Need for Store Door Delivery

Colonel Molitor said that the Island of Manhattan is already too crowded to contain "one single foot more of standard-gage track," and favored the establishment of a great joint classification and storage yard on the New Jersey meadows between Newark and Jersey City, to be supplemented by an outer belt line extending from Kill van Kull, Staten Island, out to the vicinity of Plainfield, N. J., then northward and eastward to cross the Hudson River at a point between Beacon and Camelot, from there connecting with the New York Central, New Haven, and New York Connecting Line railroads. This plan would permit of the immediate discharge of freight at the yards in the New Jersey meadows into truck bodies to the increase of car mileage. Any comprehensive plan for the distribu-

tion of freight and foodstuffs in Manhattan Island must include provision for store-door delivery, said Colonel Molitor.

Mr. Eaton, of the Federal Trade Commission, said that the subject was a public one, requiring the broadest viewpoint and emphasized the importance of store-door delivery. He said that the present situation was universally bad and that it is "up to engineers to bring forth a solution."

Cyrus C. Miller, who now acts as counsel for the associations of food distributors in New York, pointed out that the problem of food handling must be treated specially, since provision must be made for display and sale, as well as distribution and storage, and in any plan the keynote must be in every movement of commodities to go as far as possible to point of consumption.

It was suggested by Mr. Hallihan that permanent committees be appointed by the New York Section of the American Society, each of which should be devoted to a consideration of the public subjects to be discussed this season. These committees would follow up the recommendations made at the meeting to the end of presenting a final report for practical adoption.

J. B. Miller briefly presented a plan for establishing freight yards, with a capacity of 8,000 cars on the islands in the upper East River to be connected by car-ferry slips. Mr. Miller said that New York City must guard against its "becoming the suburb, and Newark the metropolis," as a result of unloading cars in the New Jersey meadows as had been proposed. In connection wit the plan for developing the East Rive islands freight subways would be provided.

Central Warehouses Proposed

The application to the port of New York of the system of handling transfer freight in demountable motor truck bodies, now in use in Cincinnati, was outlined by Mr. Fitch, of the Motor Terminals Co. As a result of a four-year engineering study, said Mr. Fitch, it is established that 50,000 tons daily in the metropolitan district are available for such service, on which the present cartage cost is $2.50 per ton and the distributing and assembling terminal cost to carriers not less than $3.50 per ton, or a total daily cost of $300,000, which by the service proposed could be reduced to $100,000, representing an annual saving of approximately $60,000,000. This plan would ultimately provide for store-door delivery through the medium of demountable motor truck bodies handled between rail and pier heads and a number of centrally located off-track or inland zone station warehouses.

Mr. Lavis presented a plan for a large warehouse and manufacturing plant terminal in Jersey City, with rail and deep water connections as a central point of distribution. The meeting was presided over by R. S. Parsons, general manager of the Erie system.

The New York Section will hold monthly meetings devoted to other civic subjects, extending until next May. The present program is as follows: Nov. 17, "Urban and Suburban Passenger Transportation"; Dec. 15, "The Port of New York"; Jan. 12, "Water Supply and Sanitation"; Feb. 16, "Light, Heat and Power"; Mar. 16, "Streets and Parks"; April 20, "Military Features," and May 11, "Bridges and Tunnels." These meetings will be held at the Engineering Societies Building, 29 West 39th St., New York City, opening at 8 p.m. The first speaker will be limited to a period of twenty minutes and will be followed by several invited speakers, to each of whom will be allotted ten minutes for discussion of special phases of the subject under consideration.

Water and Light Bond Election at Topeka, Kan.

A bond issue of $535,000 for the consolidation of the water and electric light plants and for a water filtration plant will be voted on at Topeka, Kan., on Nov. 2. Herbert J. Corwine is mayor.

Trial Lettings Proposed by New York Highway Commission

In order to determine if contractors are in a position to submit favorable proposals for highway construction, Frederick Stuart Greene, Commissioner of Highways, State of New York, has announced a trial letting for Oct. 29, when proposals for the construction of twelve highways will be received. Should this letting prove favorable, a second letting is contemplated in November for roads upon which winter work may be carried on advantageously. This intention of the highway commissioner is contained in a recent letter to the Governor and the people of the state.

Commissioner Greene considered that contracting conditions have considerably improved over those existing last April, when the highway commission announced the suspension of further letting for new highway construction. The decision to hold a trial letting was strengthened by requests from leading contractors who will shortly complete all work ahead and who are now preparing for their 1921 activities. It is the assertion of Commissioner Greene that if the state does not continue road construction many of the most reliable road contractors will be forced to seek employment elsewhere.

The 1921 program of the New York Highway Commission for new construction will be published in November and if conditions warrant, proposals will be received during February, March and April for highway construction in order that new work may be underway throughout the state early in the spring.

At the time the 1920 construction program was suspended, there were 183 roads under contract. Of these, 25 have been completed and 78 are now more than 50 per cent complete.

Water-Works Improvements Urgently Needed at Kansas City

Water works improvement urgently needed by Kansas City, Mo., within the next six to eight years would cost from $14,000,000 to $18,000,000 at present prices, according to a report to the Board of Fire and Water Commissioners submitted on Oct. 6 by George W. Fuller in behalf of Fuller & McClintock, consulting engineers, New York City.

The improvements include a filtration plant, a high level pumping station, an equalizing reservoir at the East Bottoms and necessary discharge lines to connect with the distribution system. Under existing statutory authority the city could now issue some $3,000,000 of bonds.

Mr. Fuller's report, which is a preliminary one, was made to bring to the attention of the Mayor and Council and taxpayers the "seriousness of the local water-works situation in order that the program of financing can be arranged without delay." To give added force to the urgency of the Kansas City water supply needs Mr. Fuller recommended the "calling in of several experienced local engineers as a Board of Review" to pass upon his report. This board was composed of Wynkoop Kiersted, chairman; Clinton S. Burns, of Burns & McDonnell; George A. Johnson, of Johnson & Benham; Alexander Maitland, Jr., and John Prince. Under date of Oct. 11 the Board of Review endorsed the conclusions reached by Fuller & McClintock.

Water Shortage Imminent

In their report Fuller & McClintock state that unless the recent rate of increase of water consumption is reduced "a serious water shortage is imminent by 1924." Recent water-waste reductions efforts have diminished the consumption by from 6,000,000 to 8,000,000 gal. a day. The engineers consider that it is imperative that this water waste work be prosecuted without interruption and state that "even with this being done water shortage is threatened by 1926-28." Besides the danger of a shortage the present supply is "objectionably muddy much of the time, and at intervals the sterilization process in use is seriously interfered with by the sediment in the water."

The engineers' investigation showed that the cost of the water supply from the Ozarks, the St. Joseph's district or the upper valley of the Kansas River would cost from $25,000,000 to $65,000,000 in excess of filtered water from the Missouri River. The best source of the city's supply, the report states, "is undoubtedly the Missouri River, with the water taken either from the existing site at Quindaro, or from a new site on the north branch of the river just west of the Platte-Clay County line.

Federation Endorsed

(*Continued from p. 863*)

The Federated American Engineering Societies is a going concern, and in aggregate membership represented is the largest engineering organization in the world. It has seventeen charter members; six national societies, including the Am. Inst. M. E., Am. Soc. M. E., and Am. Inst. E. E., and eleven local, state and regional engineering organizations. The Federated American Engineering Societies is based upon the principle of non-interference with the autonomy, functions and operations of its Member-Societies. Therefore, the technical activities, requirements for membership, and other functions of the society are unchanged by membership in the federation. It is not an organization of individual members. An individual can only be associated with its work through his membership in an organization holding membership in the federation.

We direct attention to the favorable legal opinion of Am. Soc. C. E.'s counsel, pages 3 and 4 of the pamphlet issued by the Board of Direction, which removes all argument as to whether the society can legally become a member of the federation.

The adoption of the amendment, increasing the dues of Non-Resident Corporate Members, provides the funds for the contributions of the society as a member of the federation. The organization will have at least four times the funds that were provided for the operation of Engineering Council, of which this society is a member.

We do not agree with the arguments against joining the federation, since a careful study of its constitution and by-laws shows that

(a) Its purpose is definite and comprehensive.

(b) It is truly representative and democratic.

(c) Its governing body, American Engineering Council, is truly representative.

(d) The requirements for membership are under the control of the Council. The American Society of Civil Engineers should, therefore, be represented on that Council.

(e) It is adequately financed.

(f) The provisions for non-technical work cover local, state, regional and national problems.

We believe that the greatest need of the engineering profession is its unification through a central representative body which will enable the profession to take its part in public affairs. The plan of organization is such as to provide the most feasible means yet proposed for bringing about a solidarity in the engineering and allied technical professions so that their united voice may be heard in matters affecting public welfare, and of common interest to members of these professions. Public opinion is influenced by numbers and in the bulk of the members of this representative organization lies its strength with the public.

If you have already voted you may withdraw your vote by dating, and endorsing over your own signature (handwritten not typewritten or printed) on the outer envelope in which you mail your ballot, "Destroy previous ballot"; the ballot should be mailed not later than Nov. 1, 1920.

VOTE *YES*
ON THE QUESTIONNAIRE BALLOT

A. H. Abel, E. L. Adams, F. H. Adams, R. W. Adams, W. H. Adams, Louis J. Affelder, Frederick W. Albert, Eugene Y. Allen, Thomas D. Allin, George G. Anderson, C. W. Anschuetz, H. F. Anthony, Richard I. D. Ashbridge, A. B. Atwater, Murray C. Ayers, Louis E. Ayres.

Edgar A. Bailey, F. S. Baillie, H. S. Baker, Percival S. Baker, Sheldon K. Baker, William D. Baker, Walter F. Ballinger, J. E. Banks, A. F. Barnard, E. C. Barnard, W. K. Barnard, John H. Bateman, George S. Beal, Willard Beahan, George L. Bean, Orville Benson, Thomas Berry, F. Phillips Best, Arthur H. Blanchard, C. K. Bowen, Edgar R. Bowen, C. P. Bower, James A. Boyle, J. S. Bright, Jacob H. Brillhart, Howard F. Bronson, Baxter L. Brown, J. L. Brownlee, John A. Bruce, L. S. Bruner, Morton Burdon, J. L. Burkholder, C. A. Burnette, W. J. Burton, A. D. Butler.

Charles C. Campbell, G. E. Campbell, J. T. Campbell, C. M. Canady, A. A. Casani, S. N. Castle, L. O. Chambers, E. Ross Chamblin, J. N. Chester, William H. Chorlton, F. D. Christhilf, H. L. Christie, George L. Christy, J. H. Cissel, Edwin Clark, Arthur L. Collins, John S. Conway, William H. Connell, M. E. Cooley, Earl L. Cope, L. F. Copeland, Dudley T. Corning, S. V. Cortelyou, William H. Courtenay, C. C. Covert, John J. Cox, C. Coykendall, William H. Crawford, Edward W. Crellin, O. W. Crowley, R. W. Crum, James F. Cullen, A. O. Cunningham.

Charles H. Dading, C. M. Daily, A. M. Danzilli, R. W. Davenport, A. L. Davis, Arthur P. Davis, Chandler Davis, Charles E. Davis, D. E. Davis, W. S. Dawley, Edwin F. Dawson, Arthur J. Decker, H. W. Dennis, F. G. Dessery, James L. De Vou, Richard G. Develin, R. G. Dieck, Clark Dillenbeck, E. C. Dilworth, Charles Y. Dixon, H. J. Doolittle, W. L. Drager, H. P. Drake, W. R. Drury, J. H. Dunlap, Edwin Duryea.

William Easby, Jr., G. S. Edmondstone, J. H. Elder, W. M. Eliot, J. A. Elliott, H. C. Ellis, C. A. Emerson, Jr., Mordecai T. Endicott, J. H. Ensey, H. H. Esselstyn, E. Evers.

E. B. Fay, George H. Fenkell, Lewis R. Ferguson, F. H. Finch, Wager Fisher, Gerald C. Fitzgerald, Edwin J. Fitzmaurice, E. T. Flaherty, R. Follansbe, James W. Follin, F. H. Fowler, James D. Fowler, J. C. Fowler, Charles Kirby Fox, Benjamin Franklin, Owen B. French, Charles Frommer, George S. Frost, Almon H. Fuller, William Copeland Furber.

B. J. Garnett, John T. Garrett, R. P. Garrett, Homer F. Gault, Joseph B. Gemberling, O. H. Gentner, Jr., Elbert A. Gibbs, W. Herbert Gibson, Frank W. Gilcreast, Frank Gillelen, C. E. Gilman, Maurice Goldenburg, Irving D. Goodwin, L. M. Gram, William H. Gravell, W. J. Graves, F. W. Green, A. E. Greene, William B. Gregory, John O. Greenway, W. G. Grove, N. C. Grover.

E. A. Hadley, H. L. Haehl, Albert B. Hager, J. C. Hain, L. S. Hall, John P. H. Hallahan, J. P. Hallihan, Milo C. Halsey, Charles Hansel, Andrew B. Hargis, Eugene L. Harman, A. F. Harter, Stephen Harris, O. F. Harting, O. W. Hartwell, T. R. Hasley, F. A. Hastings, Harry Hawgood, Charles Haydock, W. A. Heimbuecher, Francis Henderson, V. K. Hendricks, D. C. Henny, F. W. Henrici, Milton Hesselberger, Louis C. Hill, W. N. Hill, A. Hirst, F. S. Hitchcock, W. C. Hoad, L. R. Hoffman, Howard K. Holland, Ray K. Holland, S. C. Hollister, W. W. Horner, Ralph H. Hosmer, U. B. Hough, John J. L. Houston, Otis E. Hovey, R. H. Howard, C. H. Howell, John C. Hoyt, J. T. N. Hoyt, C. W. Hubbell, Richard L. Humphrey, A. M. Hunt, C. B. Hunt.

William Jackson, Reginald H. James, E. C. Jansen, Walter E. Jessup, A. N. Johnston, H. S. Johnson, Clarence T. Johnson, Alfred Jones, Benjamin E. Jones, George W. Jones, W. D. Jones, S. A. Jubb.

C. P. Keyser, Richard Khuen, Jr., Stephen E. Kieffer, Horace W. King, H. A. Klugel, Morris Knowles, R. E. Koon, O. H. Koch, Homer V. Krouse.

John F. Laboon, J. A. Lahmer, Frank R. Lanagan, Horace G. Lang, Harrison W. Latta, Fred Lavis, Ralph J. Lawrence, Augustine L. Lee, Charles T. Leeds, Theodore A. Leisen, S. H. Leister, J. H. Lewis, W. I. Lex, A. R. Lindsey, J. B. Lippincott, Eugene Logan.

Morton Macartney, J. O. MacFee, Thomas Maddock, L. T. Maenner, John Mahon, Jr., R. G. Manning, Charles Martin, James W. Martin, George C. Mc Donald C. May, H. P. McKean, Thomas Means, Charles F. Mebus, John Meigs, F. Menefee, O. C. Merrill, William W. Michell, A. A. Miller, Walter S. Miller, W. M. Michell, David A. Molitor, Frederic A. Molitor, Carl de Moll, Charles E. Mollard, S. Morris, Howard E. Moses, Harrison Mower, Hans Mumm, Jr., J. F. Murray, E. L. Myers, R. A. McMenimen, William McMenimen, S. A. McWilliams.

W. H. Nalder, C. S. Nichols, W. S. Nichols, Blaine Noice, Edward N. Noyes, Robert Norris, Emil L. Nuebling.

C. W. Ogden, Frank H. Olmsted, Roger W. Olmsted, M. J. Orbeck, N. H. Ott, Samuel J. Ott, E. H. Owen.

A.E. Palen, S. R. Parke, John C. Parker, William P. Parker, J. H. Payne, Walter Pearl, Emile G. Perrott, C. H. Pierce, John G. Pitney, H. E. Plummer, W. S. Post, B. Priest, R. F. Proctor, Charles H. Purcell, C. D. Purdon, George R. Putnam, Clyde B. Pyle.

Earl Querbach, Henry H. Quimby, J. C. Ralston.

Ralph R. Randall, H. A. Rands, Howard S. Reed, M. E. Reed, Ralph J. Reed, O. T. Reedy, Edwin R. Renz, Charles M. Reppert, G. J. Requardt, George H. Reussner, John M. Rice, H. Ridgway, H. E. Riggs, George S. Robertson, John E. Rockhold, W. E. Rolfe, W. H. Root, E. A. Rowe, J. W. Rowland, E. J. Ruff, Richard L. Russell, S. Bent Russell.

C. W. S. Sammelman, Edmond H. Sargent, J. Q. Savage, W. C. Sawyer, William R. Scanlin, Frederick E. Schall, Maurice R. Scharff, Nathan Schein, W. W. Schlecht, W. J. Schlick, H. A. Schofield, Karl D. Schwenbener, G. M. Scofield, Reginald C. Scott, H. T. Shelley, L. V. Sheridan, E. G. Shibley, E. H. Shipman, L. H. Shoemaker, J. G. Shryock, Joseph W. Silliman, J. W. Skelly, S. A. Sloan, J. W. Small, Benjamin L. Smith, C. E. Smith, Edward U. Smith, Henry C. Smith, H. S. Smith, J. Rhodes Smith, Stanley Smith, Vernon H. Smith, Walter D. Smith, George D. Snyder, A. L. Sonderegger, Harrison Souder, T. Nelson Spencer, Herman Stabler, Norman L. Stamm, O. E. Stanley, Edward B. Stearns, Felix C. Stehle, F. H. Stephenson, Eugene W. Stern, Charles H. Stevens, F. S. Stevens, J. C. Stevens, John D. Steveson, W. L. Stevenson, Harrison Stidham, Lewis B. Stillwell, H. R. Stocker, H. Struckmann, Russell Suter, S. M. Swaab, R. S. Swinton.

E. G. Taber, Arthur N. Talbot, G. Lewis Taylor, E. B. Temple, J. Hermon Terry, Neil Thom, Franklin Thomas, Carroll R. Thompson, C. W. Thorn, Albert E. Timmons, F. E. Trask, John C. Trautwine, 3rd, James C. Travilla, A. L. Trout, A. J. Turner, W. S. Turner.

J. A. Van den Broek, James H. Van Wagenen, Paul Voorhees, C. B. Voynow.

Joseph C. Wagner, Samuel T. Wagner, O. A. Walt, E. M. Walker, Edward E. Wall, O. L. Waller, R. F. Walter, W. R. Warman, Albert K. Warren, C. L. Warwick, Leonard C. Wason, David L. F. Watson, George S. Webster, Maurice A. Webster, D. R. Wells, A. J. Wenzell, F. E. Weymouth, R. C. White, W. M. White, F. W. Whiteside, Ezra B. Whitman, George F. Wieghardt, F. L. Wilcox, T. J. Wilkerson, Thomas L. Wilkinson, Charles P. Williams, Gardner S. Williams, Marshall Williams, A. R. Wilson, Lef Winship, C. O. Wisler, Francis P. Witmer, F. C. Woermann, J. W. Woermann, W. F. Wolfe, C. H. Wondries, S. L. Wonson, Glenn B. Woodruff, Irving Worthington, R. B. Wright, Stanley S. Wright, A. M. Wyman, A. S. Zinn.

Baltimore Votes on Over $50,000,000 Loans Next Week

Probably the largest total of municipal loans to go to popular vote Nov. 2 is the $51,750,000 at Baltimore. This includes $15,000,000 for water supply, $10,000,000 for harbor improvement, $750,000 for an isolation hospital and $26,000,000 for "general development." The latter contains $8,000,000 for sewerage, $6,500,000 for streets and bridges, $2,500,000 for harbor improvements other than docks, $1,150,000 for electric conduits, $850,000 for station houses and fire engine houses, $6,000,000 for new school buildings and $1,000,000 for repairs to old school buildings.

Council Approves Model License Law

Meeting at Chicago Urges Renewed Activity in Support of National Public Works Department

Approval of a model engineer license law, support for the original status of the Nolan patent office bill, authorization of a letter to various societies to revive interest in the movement for a National Department of Public Works, endorsement of a bill to put engineers in the Public Health Service on an equal footing with the medical officers and assistance in the securing of an appropriation to permit the Federal Power Commission to function formed the main business transacted at Chicago Oct. 21 by Engineering Council at a meeting in the rooms of the Western Society of Engineers, where 18 months ago the movement for a public works department was started by the representatives of more than 70 societies. Though the outcome has been successful beyond the expectations of its most ardent supporters, the report of M. O. Leighton, national service representative, who has had the matter in charge, indicated an apathy at present on the part of the various societies and many individuals to whom definite duties have been assigned. The report in full is printed on page 834.

Although its activities will soon be terminated, Engineering Council authorized a letter to the various societies calling on them for renewed support of the public works department movement. Influence needs to be exerted now, it was explained, because the committee of the next Congress will prepare the bill which may be passed at the succeeding Congress, both major parties having given approval of the principles involved. A bill of some kind will be passed, but if civilian engineers do not act quickly, it is pointed out, control will rest with the Corps of Engineers, U. S. Army.

Provisions of License Law

The model license law, as finally adopted, is essentially that which has been before Council for a year. It is a joint architects, engineers and land surveyors registration law in which an engineer is defined simply as a professional engineer. An optional exemption was added to exclude various individuals from the provisions of the law provided they did not pose as registered architects or engineers. This is an expedient to exempt the residual portion of practitioners in the profession, who are too strong to permit the bill to pass. Several of the members expressed themselves as against the principle of licensing but recognized that license laws would surely be enacted; hence the promulgation of the results of the committee's work was believed a proper procedure. L. K. Sherman, president American Association of Engineers, the *liaison* representative of A.A.E., invited to attend the meetings of Council, confirmed the views of J. Parke Channing, chairman, that the majority of engineers were in favor of licensing.

E. J. Prindle, chairman of the committee handling the matter of legislation, increasing the number and pay of the patent office employees, reported that the bill was passed as submitted by the House, but was amended in the Senate so as to reduce the force and pay. Council passed one resolution calling on Congress for a restoration of the bill to its original status and another calling on the engineers for support similar to that originally rendered in the way of acquainting their congressmen with the desirability and urgency of the measure.

Power Commission Needs Funds

The Federal Power Commission finds that the $100,000 appropriated for expenses is not available through a decision of the Controller of the Treasury. Only $5,000, the salary of the secretary, can be used. Sixty-nine applications for permits aggregating 2,000,000 hp. have been filed but the commission is unable to function in a satisfactory way. The support of Engineering Council was authorized toward getting an adequate appropriation.

The Chamberlain road bill was referred to the committee on public affairs for report.

Names which will be suggested to President Wilson as suitable candidates for members of the U. S. Shipping Board are Prof. H. E. Riggs, University of Michigan, Ann Arbor, and W. H. Adams, consulting engineer, Detroit, Mich.

The next meeting will be held Dec. 16 in Washington.

Contractors' Convention Jan. 25-27

The annual convention of the Associated General Contractors of America will be held in New Orleans Jan. 25, 26 and 27.

Illinois Section, Am. Soc. C. E. Against Federation

The Illinois Section of the American Society of Civil Engineers has passed a resolution to the effect that the society should not join the Federation of Engineering Societies. All the opinions expressed at the meeting were unfavorable, and when a request was made for a presentation of arguments in favor of joining the federation no member responded.

Highway Officials Change Convention Date

The convention of the American Association of State Highway Officials, which was scheduled to convene in Washington Dec. 8, has been postponed and will be held Dec. 13, 14, 15 and 16. The change of date was made necessary because it was found that the requisite number of hotel accommodations could not be furnished during the week first selected.

Signers of "Appeal" Suggest New Amendments

Proposals Cover Local Sections, Election of Directors, Welfare and Board of Direction

In accordance with their pledge to work for the adoption of certain changes in the constitution of the Am. Soc. C. E., in case amendments A, B, F and G were defeated in the recent ballot, a group of signers of the "Appeal for a Progressive as Against a Radical Policy" met recently and as a result of their discussion have through a committee consisting of George W. Fuller, W. T. Chevalier and J. J. Yates sent to their fellow signers of the appeal a letter setting forth the substance of the amendments which they feel are desirable and accord with their pledge. The other signers of the "Appeal" are asked to consider the letter to the end that the proposals may be urged upon the constitutional amendment committee. Copies of the letter have also been sent to this committee.

The letter covers, principally, local sections and the nomination of directors by districts, but space is given to welfare work and to the makeup of the board of direction.

Local sections, it is proposed, shall be organized under a form of charter laid down in the constitution. Membership in them shall be voluntary. Their activities and status in society administration shall not be such as to infringe the interests of society members who are not members of sections. A portion of the dues shall be remitted to them. Their functions shall be "the encouragement of members to prepare or discuss papers, to advise as to matters of policy, to study local engineering problems, to co-operate with other local sections in matters of common interest and to bring about closer personal acquaintance between the Am. Soc. C. E. members in the community."

Regarding election of directors by districts, it is proposed that the local sections shall take the initiative in nominating candidates for director. The suggested name or names would go on a ballot to be sent to every member of the district whether a member of a section or not. To be legal, the directors should finally be elected by the entire membership of the society.

For nomination of the other officers, the nominating committee would be retained but its members would be chosen by the districts themselves after the fashion indicated above for directors. It is suggested that the past presidents be removed from the nominating committee.

Opportunity for nomination by declaration would be afforded in selection both of directors and of members of the nominating committee.

Though not covered by the pledge, it is proposed that there be a standing committee on welfare, which would advise the board of direction on matters involving the material and professional interests of the members and the re-

lation of the profession to the public. It would also act under the board's direction on co-operative movements.

Regarding the makeup of the board, it is proposed that the secretary and the five past presidents be eliminated and in their place five "regional" directors be chosen, the latter to make up for the loss of representation due to the removal of the past presidents from the board. A two-year term, instead of three, is proposed for directors.

Recipients of the letter are urged to report to the committee on amendments their views on these proposals.

Civil Service Examination
United States

For the United States Civil Service examination listed below apply to the United States Civil Service Commission, Washington, D. C.

Safety Engineer. $8 per diem plus increase of $20 a month after one month's service. Applications received until Nov. 30.

ENGINEERING SOCIETIES

Calendar

Annual Meetings

ASSOCIATED GENERAL CONTRACTORS, Washington, D. C.; New Orleans, Jan. 25-27.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, Washington, D. C.; Washington, D. C., Dec. 13-16.

FEDERATED AMERICAN ENGINEERING SOCIETIES, New York; Washington, D. C., Nov. 18-19.

NATIONAL DRAINAGE CONGRESS, Chicago; Atlanta, Ga., Nov. 10-12.

The Kansas Engineering Society will hold its annual meeting at Topeka, Kans., Dec. 16 and 17.

The Southern California Section, Am. Soc. C. E., at its Oct. 13 meeting was addressed by H. W. Dennis on "A Study of Stream Flow on the Kearn River." The members voted unanimously to join in the formation of the California Engineering Council.

PERSONAL NOTES

F. P. DILLON, first assistant superintendent of the 5th Lighthouse District with office at Baltimore, Md., has been made superintendent of lighthouses of the 9th District with headquarters at San Juan, P. R., and leaves the United States this week to take charge of his new duties.

E. W. ENGLEBRIGHT, engineer, Union Pacific R.R., New York City, with his entire staff, has been transferred to Omaha, where his office will be consolidated with that of E. E. Adams, assistant to the president.

J. W. FOX, valuation engineer of the Central of Georgia R.R., has resigned to become affiliated with the Lawrence Construction Co., Augusta, Ga.

G. R. SMILEY has been appointed chief engineer of construction of the Louisville & Nashville R.R. with headquarters at Louisville, Ky., succeeding H. C. Williams, resigned.

W. C. ALLEN has been appointed assistant valuation engineer of the Fort Worth & Denver City R.R. and the Wichita Valley R.R. with headquarters at Fort Worth, Tex.

SAMUEL P. COFFIN, supervisor of bridges and buildings of the Boston & Maine R.R., has been transferred from Boston to Salem, Mass.

J. B. CROCKETT, for some time engineer of Collin County, Tex., has resigned to enter the contracting business.

LEE RILEY, hydraulic engineer, has been appointed engineer for the Leavenworth and Fort Leavenworth Water Co., Leavenworth, Kan.

E. P. ASBURY has been appointed engineer of Collin County, Tex., to succeed J. B. Crockett, resigned.

THE J. N. CHESTER ENGINEERS, formerly Chester & Fleming, announce the admittance of E. E. Banksson as a partner. The firm now consists of J. N. Chester, D. E. Davis, J. F. Laboon, J. T. Campbell and E. E. Banksson.

A. T. DICE, JR., a civil engineer recently with the Reading Iron Co., has been appointed assistant superintendent of the Reading and Harrisburg divisions of the Reading Railway with an office at Reading, Pa.

W. D. KINSEY, formerly division engineer, Reading division, Reading Ry., has been transferred to the Shamokin division as assistant superintendent, located at Tamaqua, Pa.

WALTER F. WHITTEMORE, engineer and member of the New Jersey State Highway Commission, has been appointed by Governor Edwards to serve on the State Board of Public Utility Commissioners of New Jersey.

OBITUARY

GEORGE E. DATESMAN, for 30 years in the service of the city of Philadelphia and, prior to his retirement in January, director of public works, died Oct. 18, at Germantown, Pa. He was born in West Milton, Pa., 1863 and was graduated from Lafayette College as civil engineer in 1883. He entered the employ of the city of Philadelphia in 1885, serving as draftsman until 1889, when he entered private practice. He returned to the Bureau of Surveys in 1891 and in 1893 became principal assistant engineer. In this capacity he was engaged in the design and supervision of various public works, including about 600 miles of sewers, 5 steel piers, the Aramingo Canal Improvement, dredging operations in Delaware and Schuylkill Rivers, consultations upon subway construction and the elimination of grade crossings on the Philadelphia & Reading Ry. The latter involved street alterations, sewer reconstruction, and building steel bridges. In 1913 Mr. Datesman was commissioned by the mayor of Philadephia to represent the city at the International Building Trades and Scientific Accessories Exposition at Leipzig, Germany, and to make an investigation of public works and modern methods of sewage disposal in European cities. He acted as consulting engineer on sewage disposal to the Metropolitan Sewerage Commission of New York City. He was appointed director of the Department of Public Works at Philadelphia in December, 1915.

CHARLES N. CHADWICK, commissioner of the Board of Water Supply, City of New York, died Oct. 23 at Lyme, Conn., his summer home. Mr. Chadwick was 73 years old and a resident of Brooklyn. He was a charter member and for 16 years a director of the Manufacturers' Association of New York. He was chairman of the Brooklyn Committee on Bridges and Tunnels. With the New York City Board of Water Supply his duties related to the general administrative and legal matters involved in the construction of the Catskill aqueduct.

RICHARD LAMB, consulting and construction engineer, New York City, died Oct. 18 at Brooklyn, N. Y. He was born in Norfolk, Va., Sept. 15, 1859, and was graduated from Brown University in 1883. In 1884 he acted as assistant engineer of construction, Norfolk Terminal Company's railroad from Norfolk to Lamberts Point, Va., and also supervised the building of the extensive coal pier at Lamberts Point. He made plans for the drainage of the Great Dismal Swamp, laid out in the northern section of Norfolk and also (1886) was engaged in construction of a sewer system for the University of Virginia. As chief engineer of the Wilmington, Onslow & East Carolina R.R. and of the East Carolina Land & R.R. Co. (1887-1888), he laid out routes, designed all structures and had entire charge of the construction of the roads from Wilmington to Newbern, N. C. (84 miles). In 1890 he was appointed chief engineer in charge of the Lamberts Point Co. and the Lynn Haven Syndicate, during which time he laid out and constructed streets, water and sewer work. He designed and constructed the electric cableway for towing canal boats at Tonawanda, N. Y. As engineer for the Brooklyn Dock & Terminal Co., Brooklyn, N. Y., the Navesink Improvement Co., Highlands, N. J., and the Chauncey Realty Co., Chauncey, N. Y., he was engaged in designing roads, bridges, sewers and water-works.